POWER

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Energy

"GIVE me matter and energy," once said a famous scientist, "and I will make a world."

Matter and energy, both apparently uncreatable and indestructible.

When carbon is burned — and our fuels are principally carbon — the atoms of oxygen and carbon are drawn together, probably by the same kind of attraction that draws bodies to the earth. The energy of motion which they acquire in this falling together is what we recognize as heat. The greater the velocity that they acquire the greater their temperature.

The atoms of oxygen and carbon are now bound together. Combustion means their combination. It takes as much energy to pull them apart as was produced by their union, just as it takes as much energy to lift a weight that has fallen to the earth as it developed in falling. In the laboratory we are able to effect this separation only under extreme manifestations of force and pressure.

But in that most delicate of structures, the vegetable cell, under some mysterious impulse gathered from the firmament, this running-down process is reversed. The weight is lifted, the centers of gravity of the atoms are forced apart, and that which we can do only in the strongest of vessels and by the use of intense force is brought about silently and naturally without any appearance of effort in a simple green leaf, waving in the sunshine.

Where does the energy to do this come from? So far as we can see, from the sun. The sunlight shining upon a field of corn decomposes carbonic acid, builds the carbon into the structure of the growing plant and sets the oxygen free in the atmosphere. Man eats of the corn and builds the carbon into his tissues. He breathes the air, and its oxygen reunites with the carbon, generating the energy which impels his actions. He strikes a blow with a sledge, and the molecules of the metal that receives the blow are set into the brisker motion that we call a rise in temperature. The heat radiates out into the universe. The motion of the molecules of the iron are communicated to the ether or whatever it is that fills the interstellar space

Ages ago the sunlight fell upon the luxurious growth of the carboniferous period and its energy was absorbed in the same way. Geological changes buried and transformed the masses of vegetable matter produced into coal and oil. We burn these fuels in our engines and the energy produced is eventually, by friction and effort, transformed into heat and radiated out into the universe.

Where does it go to? If it is indestructible, it must persist.

Scientists tell us that the clock is running down; that heat tends to a dead level of temperature as water tends to the level of the sea. But this is a mournful and repugnant finish to contemplate of a world without end. And I like to think that if we could follow these rays of energy of which so many kinds that we little dreamed of have recently been discovered, we should find some process by which they are concentrated into the apparently inexhaustible flow of warmth and energy that comes to us from the sun and other stars.

J. R. Low

Fulton Market Cold Storage Plant, Chicago

Economical synchronous-motor-driven refrigerating plant to have eventually 10,500,000 cu.ft. of storage space and 888 tons of refrigerating capacity. The compressors are two-stage machines with injection of liquid between stages and a pipe coil in the intermediate drum to precool the ammonia liquor on its way to the brine coolers. Longevity, reliability and low maintenance were secured in direct-connected units having the medium speed of 80 r.p.m.

ONE of the recent additions to cold-storage space in Chicago is the new plant of the Fulton Market Cold Storage Co., situated in the heart of the district that it is anticipated will replace the present South Water Street produce market. The reinforced-concrete building is ten stories and basement. In plan it is approximately 125 x 300 ft. The stories are all 12 ft. from floor to floor, except the first, which measures 14 ft. 9 in., and the north half of the basement containing the engine room. The gross volume of the present plant is 5,472,000 cu.ft., and when the second section is added, this figure will be increased to 10,500,000 cu.ft. If the floors are loaded up to the figure used in the design, the capacity of the present plant will be about 75,000,000 lb. From the second floor and up this space is evenly divided between coolers and freezers.

Insulation against outside temperatures is secured by means of compressed corkboard, which envelops the refrigerated portions of the building. In order to have this cork insulation complete and unbroken, an exterior enclosure is separated from it by a distance equal to the thickness of the corkboard. The Chicago building laws do not sanction the use of a self-supporting brick wall for this exterior structure, but require that this outside wall be supported on a separate framework of reinforced-concrete columns and spandrel beams. This is the construction at Fulton Market. There is a clear space of 5 to 7 in. separating the inside and outside structures. These are tied together by means of single-bar anchors located at each column head of the interior framing. With the exception of these few ties the cold rooms are completely and effectively insulated from the outside. All doors to refrigerated space have the same insulating value as the walls in which they are hung.

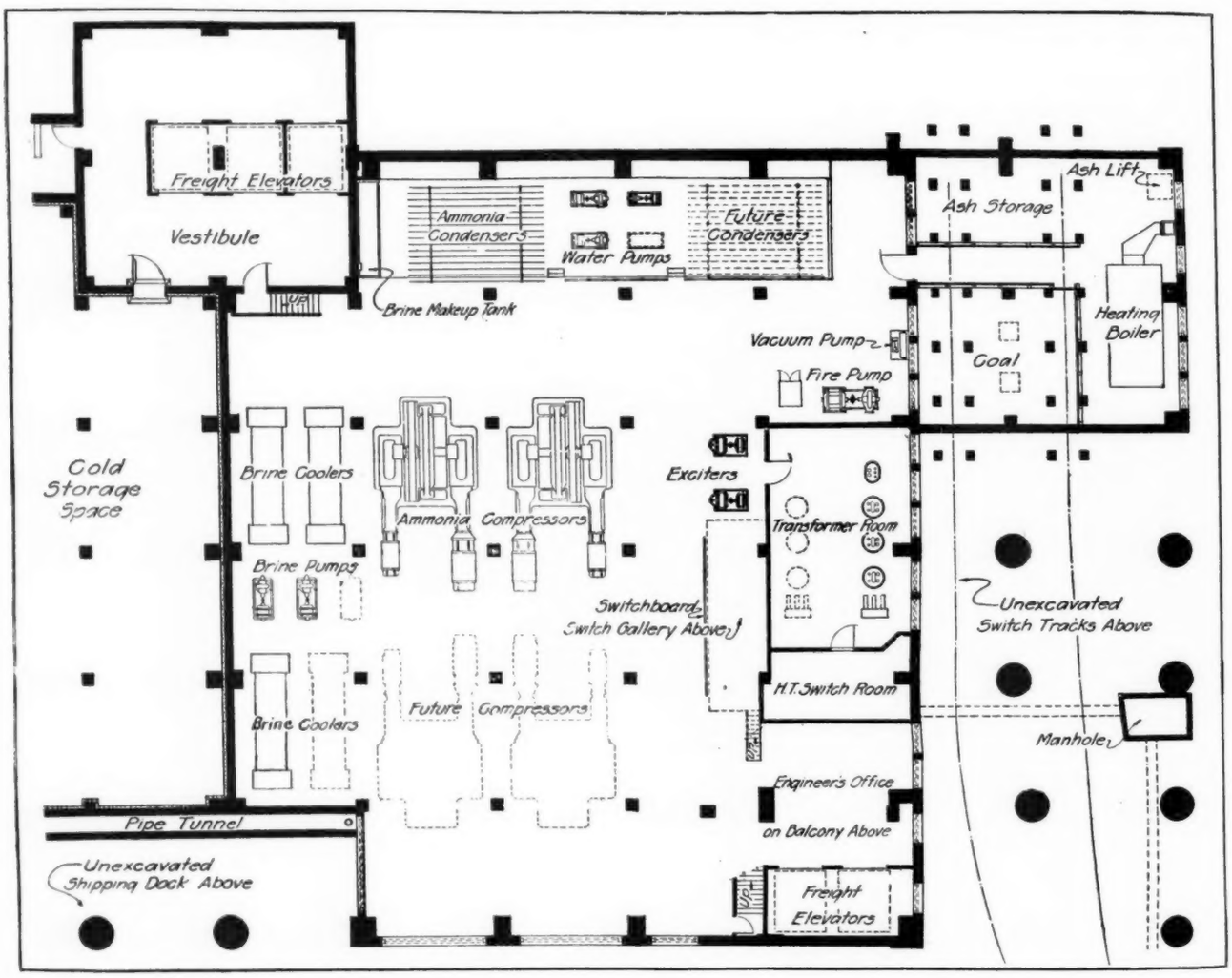

FIG. 1. LAYOUT OF THE MECHANICAL EQUIPMENT OF FULTON MARKET COLD-STORAGE PLANT

The roof is insulated with corkboard, laid on top of the roof slab. On top of the cork is a covering of cinders averaging 2 ft. in depth, which gives the proper pitch to the 2-in. concrete slab on which is laid the composition roofing.

The plant is provided with three private switch tracks, two of which are within the building. These will be extended when the future section is added, and will then enable the placing of eighteen cars at one time.

There is also a wagon platform at the side 146 ft. long and sheltered. Connecting the wagon platform and the railroad platforms are wide trucking corridors, and the five electric freight elevators, which travel at 200 ft. a minute and have a capacity of 4,000 lb., are adjacent to these.

In the basement of the building is the engine room, this space being excavated to the additional depth of 6 ft., thus giving 18 ft. headroom. There is ample space for four compressor units, of which two have been installed. Of the two future machines there is a possibility that one may be an ice-making unit and the other a spare for the two refrigerating machines installed. This equipment will not be needed until the final addition is made to the warehouse.

A careful analysis of the relative advantages of steam and electric drive resulted in the selection of synchronous motors to drive the compressors and the exciter sets. To eliminate belt loss, these motors are mounted on the shafts of the driven machines. Although the brine, water-circulating and other pumps are induction-motor-driven, the synchronous-motor capacity in operation is always large enough to insure unity power factor. In this way maximum economy is obtained, and a load of this character has proved so desirable to the service company supplying the electrical energy that for some time a special wholesale

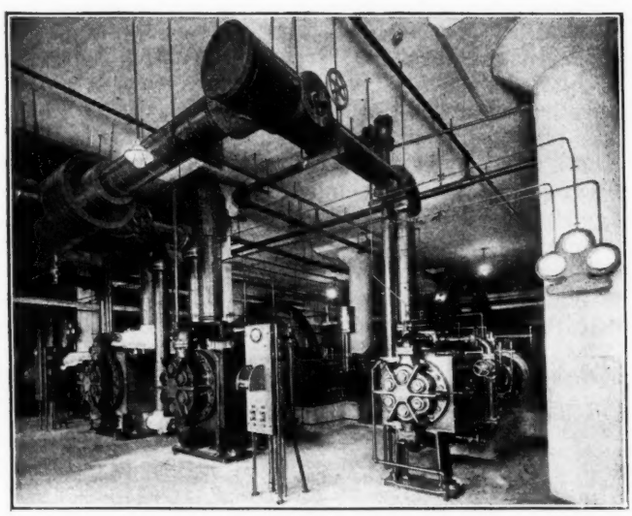

FIG. 2. SYNCHRONOUS-MOTOR-DRIVEN COMPOUND AMMONIA COMPRESSORS

rate of one cent per kilowatt-hour, and lower when the load for the month exceeds 50 per cent of the maximum, has been in effect. Off-peak service is enforced only during the months of November, December, January and February. From 4 to 8:30 p.m. during this period, current, if used, must be paid for at a higher rate. By keeping the brine pumps in service, it is a simple matter to shut down the main units during the peak, particularly in the colder months, so that the penalty earned is held to a minimum, the current being paid for at the usual rate.

Since Jan. 1 of this year the rate earned has approximated one cent, and during the warm months of the past summer it has been as low as 0.85c. per kilowatt-

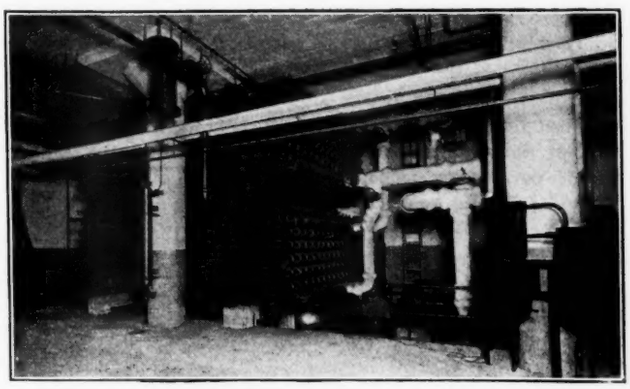

FIG. 3. DOUBLE-PIPE AMMONIA CONDENSERS

hour. This one item was a big factor in the selection of electric drive. Other reasons given were the space saved for refrigerated storage that would otherwise be required for a boiler room and coal storage, less space occupied by the electric-driven units and less heat flow to be overcome by refrigeration. In fact, in the present plant it has been necessary to install a heating boiler and radiation to keep the offices and compressor room comfortable during the winter. For a plant of the present size, electric drive would also insure considerable saving in labor and running repairs and supplies.

To insure longevity and low maintenance, a conservative compressor speed of 80 r.p.m. was selected and a motor of the same speed for direct connection. For a motor this speed was the lowest obtainable. As a consequence the machine is large and of the massive proportions that increase the initial cost, but insure long life and reliable service at small cost for maintenance.

The two machines installed are of the two-stage compression type having 28 x 42-in. low-pressure cylinders, and 16 x 42-in. high-pressure cylinders. One of these units, when operated at zero gage suction pressure and 170 lb. condenser pressure, will give approximately 296 tons of refrigerating capacity daily at 80 revolutions per minute.

Between the low- and the high-pressure cylinders of each compressor is an ammonia drum which acts as a reservoir when operating under two-stage compression. The pressure in this drum normally will be about 50 lb., and liquid is injected with the incoming gas to bring its temperature down to the saturation point and thus improve the economy of compression in the second stage. This drum is also provided with a pipe coil inside, and the piping is so arranged that the ammonia liquor may be passed through it and thereby be precooled before being fed into the brine coolers.

Ammonia condensers of the double-pipe counter-current type are also located in the compressor room. They consist in all of 32 stands of 3- and 2-in. full-weight special ammonia pipe, each stand being 12 pipes high, with a total over-all length of 21 ft. exclusive of

headers. These are arranged in two independent units of 16 stands each and, as installed, are mounted one unit directly above the other. Provision has been made for two additional units of the same size if required at a future date. The usual operating range is from a suction pressure of zero gage to 120 to 140 lb. condenser pressure during the winter and not above 180 lb. during the hot summer months.

Condenser water is taken from the city mains and is recirculated over a cooling tower located on the roof of the building at an elevation of 145 ft. above the compressor-room floor. It is guaranteed to cool 1,800 gal. of water per minute to within four degrees of the wet-bulb temperature when the dry bulb is at 80 deg. or above, and with an evaporation loss not greater than 5 per cent of the total circulated.

Two motor-driven centrifugal pumps rated at 1,000 gal. per min. against a total working head of 85 ft., are used to circulate the condenser water. The motors are of the induction type rated at 40 hp. each. In addition to these two pumps there is a smaller one for initial charging and makeup, rated at 100 gal. per min., against a total head of 150 ft. It is driven by a 10-hp. induction motor. All of the principal pumps are of the horizontal split-case type and are bronze-fitted.

Current for the plant is supplied from the 12,000-volt underground system of the Commonwealth Edison Co. The power is supplied through three 500-kva. 12,000/440-volt water-cooled transformers, and the lighting through two 50-kva., 12,000/110-volt transformers. The three-wire system is used for the lighting distribution. The transformers are in a fireproof vault back of the switchboard and the main oil switches on a gallery back of and above the board. The main power circuits are protected by automatic oil circuit breakers fitted with overload and low-voltage relays. Except for the line and the exciter switches the circuit breakers are solenoid operated, the operating current being supplied by the exciters. Two 50-kw. motor-generator units furnish the excitation for the synchronous-motor fields. The exciters are driven by synchronous motors operated and controlled from the main switchboard.

For driving the ammonia compressors, the large synchronous motors are 600-hp. three-phase machines of the split rotor and stator type, making 80 r.p.m. They are mounted on the compressor shafts and are equipped with compensators to start as induction motors. Independent flywheels were preferred to the new method of putting the additional weight in the rotor. The starting panels are mounted back of the motors between the two compressor cylinders, and each is equipped with an ammeter, starting compensator mounting, field discharge switch and two control switches with red and green bull's-eye indicating lamps. The wiring is so arranged that while the switch at the motor is to be used for starting, parallel switches on the main board can be used for cutting the motor off the line.

The switchboard consists of twelve panels. The bus-bars are suspended from the balcony, behind the board. The large motors are started as induction motors through grid-type compensators and interlocking triple-pole single-throw solenoid-operated switches. The main supply and control wires for the motors are run in iron conduit below the floor.

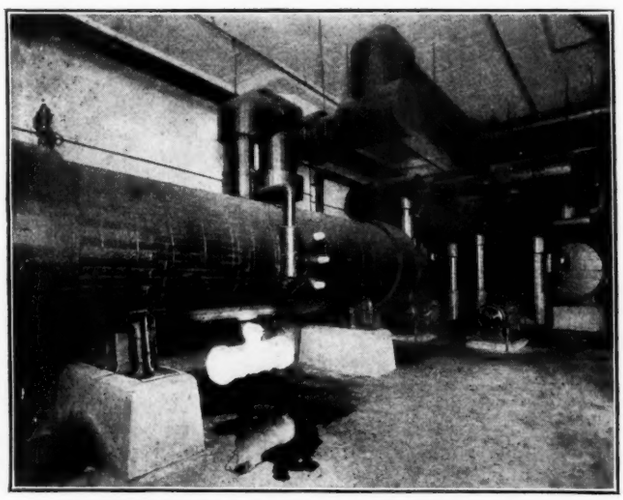

FIG. 4. BRINE TANKS AND PIPING, SHOWING CORK INSULATION

In all cold rooms, freezers and coolers alike, the application of refrigeration is by means of the brine-circulating system. Calcium chloride brine at a temperature of about 15 deg. F. is circulated through steel-pipe coils distributed throughout the various rooms. This brine is in turn cooled in large multi-pass brine coolers in which anhydrous ammonia is the refrigerating medium.

Only one temperature of brine is employed, the reason being that the refrigeration requirement for non-freezing space is so much less than for freezer space, that the extra overhead on cost of additional piping

PRINCIPAL EQUIPMENT OF FULTON MARKET REFRIGERATING PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Compressors	Horizontal, two-stage	28x16x42-in.	Refrigerate building	296 tons at zero suction, 170 lb. cond. press. and 80 r.p.m.	Ball Ice Machine Co
2	Motors	Synchronous	600-hp	Drive compressors	440-volt, 3-phase, 80 r.p.m.	General Electric Co.
3	Transformers	Water-cooled	500-kva	Supply power	12,000-440 volt	General Electric Co.
2	Transformers	Oil-cooled	50-kva	Supply lighting	12,000-110-volt, three-wire	General Electric Co.
2	Exciters	Syn. motor-generator	50-kw	Excitation to comp. motors	440-v. a.c., 110-v. d.c., 1,200 r.p.m.	General Electric Co.
2	Condensers	Double-pipe	16 stands, 12 pipes high.	Condense ammonia vapor.	Counter-current	Ball Ice Mach. Co.
1	Cooling tower	Natural-draft	1,800 g.p.m.	Cool condenser water	145 ft. above engine room floor	Water Cooling Equip. Co.
2	Pumps	Centrifugal	1,000 g.p.m., 85-ft. head.	Circulate condenser water.	Driven by Allis-Chalmers 40-hp. ind. motor	Hill Mach. Co.
1	Pump	Centrifugal	100 g.p.m., 150-ft. head.	Initial charging and make-up	Driven by Allis-Chalmers 10-hp. ind. motor	Hill Mach. Co.
3	Brine Coolers	Hor. multi-pass	50-in. diam., 18-ft. long.	Cool brine	125 tons refrigeration, 20 deg. brine	Henry Vogt Mach. Co.
2	Pumps	Centrifugal	1,500 g.p.m., 50-ft. head	Circulate brine	Driven by Allis-Chalmers 40-hp. ind. motor	Hill Mach. Co.
1	Pump	Duplex	4½x6 in., 150 g.p.m.	Charging brine	Driven by Lincoln 7½-hp. motor, 1,200 r.p.m.	Union Steam Pump Co.
1	Pump	Underwriter	1,000 g.p.m.	Fire	Driven by 125-hp. Northwestern ind. motor	Dayton-Dowd Co.
1	Boiler	Firebox	7,500 sq.ft.	Heat portion of building	Steam at 1 lb. press. to vac. system	Kewanee Boiler Co.
1	Pump	Rotary	300 gal. per hr.	Vacuum on heating system	Motor-driven	Nash Engineering Co.
5	Elevators	Overhead traction	4,000 lb.	Handling of products	200 ft. per min.	Montgomery Elevator Co.

United Cork Co. corkboard insulation; Jamison cold-storage doors; G.E. switches and relays; Westinghouse instruments; Armstrong sectional cork pipe covering; Nugent gravity oiling system.

and a separate machine for handling the gas at higher back pressure proved on calculation to outweigh the additional power requirement for the adopted scheme.

To cool the brine, there are three horizontal multipass brine coolers in the compressor room. These coolers are 50 in. in diameter and 18 ft. long, and are rated at 125 tons of refrigeration when operated with —20-deg. brine. Centrifugal pumps rated at 1,500 gal. per min. against a 50-ft. head, handle the brine. Permanent brine makeup equipment also has been installed and consists of a steel tank for dissolving the calcium and a motor-driven pressure pump for charging.

Provision has been made for line surges and expansion and contraction of the body of brine by installing a surge tank at the highest point of the system. The brine supply risers decrease as they go up, but the return riser, beginning with the lowest coils, increases in size going up, and finally discharges into the surge tank. The drain from this tank then goes to the compressor room and constitutes the pump suction.

In the various rooms the coils are all of 2-in. standard wrought-steel pipe, made up in groups, no single pair of supply and return valves handling more than about 300 ft. of pipe. They are hung from the ceiling and vary in depth from a single layer to three deep. In the coolers the coils are located directly above the aisles in order to prevent dripping on the stored goods and also to permit using the entire storage height for the piling of goods.

To the entire plant protection is afforded by an automatic sprinkler system, most of which is arranged on the dry plan. A separate dry valve is provided for each two floors per section, and instead of being located all at one point in one of the lower stories, they have been distributed on the various floors, all the way up, thereby eliminating a great confusion of risers. The sources of water supply consist of two 20,000-gal. storage tanks located in the penthouse above the central elevator, and a 1,000 gal. per min. fire pump located in the compressor room.

Heat for the offices, compressor room, stair wells and sampling rooms is furnished by a vacuum system. The boiler room is adjacent to the compressor room and is equipped with a 7,500-sq.ft. firebox boiler and the necessary vacuum pumping equipment.

All steam mains are insulated, as are the risers wherever they pass through unrefrigerated rooms. The brine coolers and all brine piping and ammonia suction lines in the compressor room, as well as the brine pumps, are insulated with cork covering.

Credit for the design of the complete plant, including the building, and supervision of the installation is due Gardner & Lindberg, consulting engineers, of Chicago.

Hand-Fired-Boiler Performance in France

By Carroll F. Merriam

In a report of the First Subcommittee of the Commission for the Utilization of Fuels, published in the April 23 number of the *Revue Generale de l'Électricité* (Paris) there appear some data intended to show the average efficiency of hand-fired boilers in France, together with an analysis of the losses. These, however, should not be accepted without some explanation and are not directly comparable with the figures on which we base our ideas of boiler efficiency.

These tests were selected from a great number conducted by the "Association alsacienne des Proprietaires d'Appareils à Vapeur" to exclude all in which the conditions were abnormal either in regard to the conditions of the test or the nature of the fuel. The regular routine of every-day operation was not disturbed and all tests lasted at least twenty-four hours, so that the average efficiency should include the losses during the night or when the fires were banked. These tests were made on practically all the types of boilers in ordinary use in that country, about half of which had economizers, the latter being included in the test. The results therefore show the over-all efficiency of boiler, grate and economizer combined.

Average Efficiency

The average of the fifty tests so selected is 65.7 per cent, based on the lower heat value of the coal; that is, the loss of heat caused by the vaporization of the moisture formed by the burning of the hydrogen contained in the coal is not charged against the boiler, as is the case when the results are based on the upper heat value as determined in the bomb.

For the sake of analysis the tests are divided into three groups in which the efficiency is poor, medium and good as follows: Class A below 60 per cent, Class B between 60 per cent and 70 per cent, and Class C above 70 per cent. The results are recorded in Table I.

TABLE I. AVERAGE RESULTS OF FIFTY TESTS OF HAND-FIRED BOILERS

	General Average	Class A	Class B	Class C*
No. of installations	50	10	23	17
No. of economizers	29	2	10	17
Ratio of total heating surface to grate area	39.6	28.9	46.3	74.3
Heat value of fuel, B.t.u., per lb.	12,490	11,870	12,470	12,900
Coal burned per sq.ft. of grate per hour, lb.	15.2	15.8	15.0	15.0
Water evaporated from and at 212° per sq.ft. of heating surface per hour.	3.24	2.65	2.70	1.98
Equivalent evaporation per pound of coal, lb.	8.45	6.66	8.28	9.82
Average CO_2, per cent	8.7	9.06	8.27	9.04
Efficiency, per cent	65.7	54.5	64.5	73.8
Loss to heat carried away by flue gases, per cent	18.2	22.0	20.5	12.7
Loss due to combustible gases in the flue, per cent	6.0	11.0	5.5	4.9
Loss due to unconsumed carbon in the ash, per cent	3.5	4.5	3.5	2.5
Loss due to cooling during night, per cent	3.3	4.0	3.0	3.0
Radiation and unaccounted for, per cent	3.3	4.0	3.0	3.0

* Class A, less than 60 per cent efficiency. Class B, between 60 and 70 per cent Class C, above 70 per cent.

The general trend of these figures shows that the higher efficiencies are due rather to the use of the economizer than to any difference in the fire conditions, the rate of combustion being the same in Class C as in Class B. The lower rate of evaporation in Classes B and C is brought about by including the economizer with the boiler in the total heating surface. The heat balance shows that, except for differences in the loss from incomplete combustion and from unconsumed carbon in the ash, the increase in efficiency in Class C is due primarily to the greatly lowered temperature of the escaping gases, as indicated by a materially lower heat loss in the flue. On the other hand, the low efficiencies in Class A are caused not only by the lack of economizers, but by poor fire conditions, as shown by the high loss from incomplete combustion. This would indicate carelessness on the part of the firemen or a coal that is difficult to burn successfully.

It will also be noted that the better the quality of the coal the better the efficiency, which would point to the fact that, on the whole, it is harder to burn low-grade fuels efficiently than high, probably because the ash is an

element which is detrimental more than in proportion to the actual percentage.

Whereas these figures cannot be compared directly with the efficiencies of American boilers under test conditions, it is by no means proved that there is much difference between French and American boiler performance under operating conditions. There is a great difference between test and actual conditions, as few tests are run to show the average day-in and day-out efficiency, inclusive of shutdowns and stand-by losses. The typical heat balance given on page 898 of Marks' "Mechanical Engineer's Handbook" shows a difference, for example, of more than 7 per cent between the efficiencies under test and operating conditions. At the time at which these tests were run—that is, during the three years preceding the war—the boilers representing the average conditions in industry were of comparatively small capacity and ranged in heating surface from 312 to 1,720 sq.ft. Today, on account of the impetus given to the development of larger and more economical boilers, these tests are no longer strictly representative. Still we have in operation a great many boilers in many respects not unlike the ones on which these tests were run, and it is probable that the over-all efficiency of such plants is surprisingly low.

To reduce the heat balances to a basis on which they can be compared, the one just referred to in Marks' "Mechanical Engineer's Handbook" has been corrected to omit the loss due to moisture formed in burning hydrogen in coal; and the losses due to the moisture in the coal and to heat carried away in dry chimney gas are combined. In the French heat balance, correction is made to omit the item of night and stand-by losses. The results have been tabulated in Table II.

TABLE II. COMPARISON OF AMERICAN AND FRENCH BOILER PERFORMANCE

	American Boiler Performance		
	Test Conditions	Operating Conditions	French Tests
Heat absorbed by boiler	78.49	70.89	68.0
Carried away by chimney gases	12.66	17.28	18.8
Incomplete combustion of carbon	1.41	1.84	6.2
Unconsumed carbon in ash	2.77	4.91	3.6
Radiation and unaccounted for losses	4.67	5.08	3.4
	100.00	100.00	100.00

The most marked difference between these balances lies in the fact that in the French tests the loss from incomplete combustion is out of proportion to the other losses. This is significant of the fact that in installations where there is a tendency toward insufficient draft, where the coal is likely to be rather high in volatile matter, and where there is, even at present, a lack of the many aids to scientific combustion control, there is a great danger of introducing considerable waste from this source.

The high efficiency of 78.49 per cent shows what it would be possible to do if the heat that is carried away by the steam formed by the burning hydrogen could be regained. To do this would mean that the flue gases would have to be cooled to the temperature at which this moisture would condense. At present, however, there is no way of doing this since the formation of moisture in the economizer is to be avoided, as it would lead to rapid deterioration.

The data given in Table III are taken from the reports of two tests on boilers built by the "Societe Alsacienne de Constructions Mecaniques," Belfort, France.

The efficiency, if figured by the steam tables of Marks and Davis, will appear slightly lower, 81.5 and 84.7 respectively. Although even these stand higher than any authentic efficiency so far attained with coal-fired boilers in America (Marks' M. E. Handbook), still the figures are not directly comparable because the lower heat value is used and because the efficiency comprises that of the boiler and economizer combined.

With the development of the air preheater even higher efficiencies are claimed by this same company, they having in their own plant two boilers so equipped giving remarkably good results. The trend of the present development in France seems to be in this direction, as it is believed that there is gain not only directly from the heat returned to the furnace, but also through better combustion resulting from higher furnace temperature.

TABLE III. RESULTS OF TESTS ON TWO BOILERS OF THE SOCIETE ALSACIENNE DE CONSTRUCTIONS MECANIQUES

Date	9-7-09	6-30-10
Duration	7h 30m	8h 00m
Heat value of fuel (lower), B.t.u. per lb.	13,280	13,460
Lb. coal burned per sq.ft. of grate	25.6	27.3
Refuse, per cent	8.5	8.41
Heating surface, sq.ft.	1,347	3,230
Equivalent evaporation per sq.ft. per hr.	7.76	8.15
Temperature of feed water, deg. F.	75.2	88.7
Temperature of water leaving economizer, deg. F.	219.2	199.8
Steam pressure, lb. gage	177.5	172.0
Superheat, deg. F.	229.	327
Factor of evaporation	1.330	1.370
Draft at exit of boiler, in. water	0.48	0.71
Per cent CO_2	13.4	11
Temperature of flue gases, deg. F.	403	291
Water evaporated per lb. of fuel	8.49	8.769
Evaporation from and at 212 per lb. of fuel	11.22	12.06
Efficiency, based on lower heat value of fuel and inclusive of economizer	82.18	86.36
Loss due to heat in escaping gases	10.5	7.614
Other losses, by difference	7.32	6.026

The use of the economizer seems to be more established in France than in America, although some plants are today being erected without them, pending further developments. At the same time there is a great deal of interest shown in the subject of the prevention of corrosion. Several methods are in use, one being to let the water spend its force, as it were, on oxidizing steel turning and other worthless material before it enters the economizer, another being to suspend a bar of zinc in the middle of each tube to form a galvanic cell.

High Superheat Preferred to High Steam Pressures

For the sake of over-all plant efficiency, high superheats are looked to rather than higher steam pressures, although there is beginning to be a move toward American practice in this respect. In order to reach the maximum steam temperature under all conditions of load without exceeding the point at which the steam would be too hot, mixing valves are used by which saturated or slightly wet steam on its way to the superheater may be mingled in with the highly superheated steam in the desired proportions.

On the whole it may safely be said that the French engineers are making strides toward better efficiencies under the pressure of the high price of coal. Unfortunately, educational work which would tend to better operating conditions is slow, for the reason that in France there is no adequate way of bringing information and guidance directly to the man on the job. The ability of our engineers and firemen to come in contact with one another, to read what others are doing, to keep in touch with the progress that is being made, to know what improvements are on the market, is, after all, a factor in the reduction of the margin between efficiencies under test and operating conditions.

[The American results in Table II are doubtless intended to be typical of the better plants only. The efficiencies shown in Table III have recently been exceeded in this country—Editor.]

Repairing Large Alternating-Current Generators—Rewinding

Placing the Coils in the Slots—Methods of Heating the Coils—Drying Out the Machine—Measuring Insulation Resistance—Placing the Machine into Service

BY N. L. REA
Construction Engineer, General Electric Company

AFTER the stator core has been assembled and the slots filed smooth, as described in Sept. 13 issue, the next step is to install the winding. The proper handling of the coils will depend on their size and shape, the kind and amount of insulation and its condition. Old coils must be handled more carefully than new ones as the insulation may be hard and brittle from long service at high temperatures.

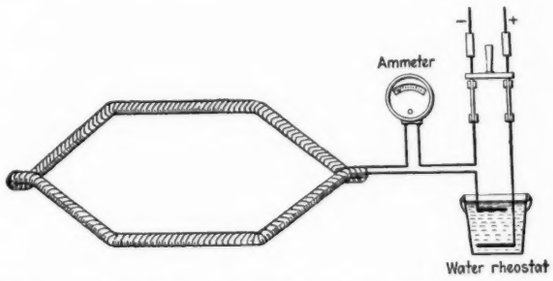

FIG. 1. CONNECTIONS FOR HEATING ARMATURE COIL WITH DIRECT CURRENT

New coils will be brittle if handled at low temperatures.

Bar windings can usually be safely handled at ordinary room temperatures. Low-voltage, formed coils that do not require much bending can be installed at room temperature except when making up the final lap. These joint coils should be heated before bending to insert the bottom coils. In general, however, coils should be heated to about 140 or 150 deg. F. before being placed in the slots or bent for any reason. Heating can be accomplished by passing a direct current through the coils, as in Fig. 1. This is advisable where only a few coils are involved and should always be used before bending them at the divisions in the winding. Large coils in which the slot armor is cemented to the coil must be heated with current, for external heat will loosen the slot armor long before the interior of the coil is hot enough. The full-load current through the individual coils can be figured from the full-load current of the machine and the number of multiple circuits in the armature. In general, a direct current of the same value will give the desired temperature in a few minutes. There is, of course, no air circulation and the coil heats up rapidly. Care must be used, therefore, to prevent overheating the coils by applying too much current. It is possible to damage the internal insulation of a coil before the exterior shows distress. This is especially true on high-voltage coils which may have considerable temperature lag due to heavy insulation.

Where there are a lot of coils to handle, an oven is advisable on account of the saving in time. There are many men of many minds when it comes to building ovens. The size of the oven will, of course, depend on the number of coils to be handled, the number of winders and the speed desired. In general, the coils should remain in the oven two hours at least to get thoroughly warmed through.

The arrangement shown in Fig. 2 has survived long experience in field work. The racks for carrying the coils can be made of 2 x 4-in. wood with the corners rounded and covered with burlap or canvas. They should be as near the top of the box as possible and a little above the center of the door. This prevents too much heat being lost through the open doors. The doors should swing upward and be provided with counterweights and stops to prevent their opening more than about 60 or 70 deg. The opening should be high enough so that a man can see to put coils in the oven and remove them without stooping. The box can be made of scrap lumber covered with building paper. It can be lined with sheet asbestos, or better still, bright tin tacked to battens. This latter arrangement will, in my opinion, lose less heat from radiation and is

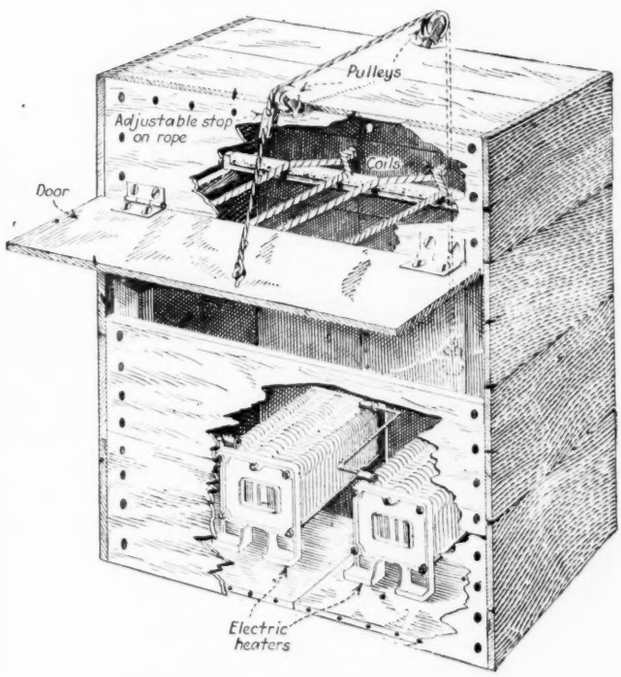

FIG. 2. OVEN FOR HEATING COILS

about as fireproof as the asbestos. Heat can be supplied by electric heaters, steam radiators or, when electricity or steam is not available, a small hot-air furnace can be set up alongside the oven and piped to supply hot air to it. Failing a furnace, a sheet-iron jacket can be placed around a small stove and this jacket piped to the oven. In either of the latter cases, dampers should be provided in the pipes to the oven

and one of the elbows replaced by a tee. This tee should have a damper or adjustable cover to permit of the hot air discharging into the open, in case the stove or furnace gets overheated. This arrangement is, at best, a makeshift and must be watched very carefully to prevent damage to the coils from overheating. A stove or oil heater should not, under any circumstances, be placed directly in the oven. The risk from overheating and fire is too great.

Having completed the rewinding and reassembling, the next step is drying out the machine. The amount of drying necessary will depend altogether on local conditions. If the room is warm and dry and all the windings have been through the oven, very little drying will be necessary. On the other hand, if a fire hose was turned into the machine at the time of the burnout, there may be a real job of drying. In any case, it is advisable to play safe and dry the machine by short-circuit heat run until the insulation reaches a value in megohms equal to or in excess of

$$\frac{\textit{Rated voltage}}{\textit{Rated kva.} + 1{,}000}$$

Possibly a short description of the connections for drying by short-circuit would be of interest. There are, of course, several ways of accomplishing this, but the writer prefers the following method:

Fig. 3 shows a typical diagram of connections. The short-circuit should preferably be made by connecting cables or copper bus across the generator side of the disconnecting switch *A*. This should, of course, be done while the machine is shut down. The generator oil switch and the disconnecting switch *B* should be locked open or otherwise safeguarded so they cannot be closed to throw the generator or the short-circuit on the bus. It is safer to have no switches between the generator and the short-circuit, as someone might

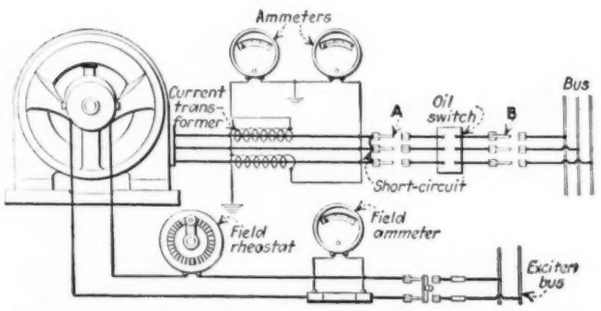

FIG. 3. CONNECTIONS FOR DRYING OUT GENERATOR WINDINGS BY SHORT-CIRCUIT

open them during the short-circuit heat run and the sudden increase in voltage prove disastrous to the insulation.

It is usually safe to use the full-load current of the machine for the short-circuit heat run, but there are rare exceptions to this rule. Special machines are sometimes designed with high internal reactance to limit the current under short-circuit conditions. These machines may require more field current to give full-load current on short-circuit than that for full-load normal voltage and the iron might reach dangerous temperatures under these conditions. This can be guarded against by watching the field ammeter as the heat run is started, and, if the current comes anywhere near the normal operating value, the short-circuit current should be increased slowly in steps with at least two hours between them.

If the machine is provided with a temperature indicator, watch it carefully, and, failing this, place thermometers to show the temperatures of the coils and of the iron. These thermometers can be held in place

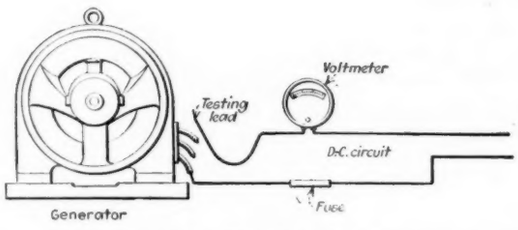

FIG. 4. CONNECTIONS FOR MEASURING INSULATION RESISTANCE WITH VOLTMETER

by putty, which should be carefully removed at the end of the drying.

Inspect the machine frequently and carefully during the heat run. The inspection should be especially thorough at the start of the run. The best of men are liable to get a coil short-circuited in reconnecting, or there may be some old coils that looked all right on the outside, but that are short-circuited internally. These will show up quickly and if caught in time will not damage adjacent coils or the iron.

Let your nose be especially inquisitive around the ventilating ducts, as you can smell hot insulation long before you can see anything wrong. It is a good idea to put the short-circuit heat run on in gradual steps and look the machine over between each step. The same procedure can be used to advantage in bringing the machine up to voltage after the drying is completed.

The following method gives a ready means of measuring the insulation resistance when a Wheatstone bridge or low-reading megger is not available: The equipment necessary consists of a direct-current supply and a direct-current voltmeter. Test the direct-current circuit with the voltmeter for grounds by connecting one side of the voltmeter to the frame of the machine and connecting the other side of the meter to both sides of the circuit in succession. If one side gives a very low reading or no reading at all, connect that side of the circuit to the machine windings through a small fuse—say 10 ampere, as in Fig. 4. (Care must be exercised, since there may be a grounded circuit, and connecting the ungrounded side to the windings would cause a short-circuit if the windings are grounded, with surprising, if not disastrous, results. Connect the other side of the direct-current circuit to the voltmeter, as in the figure, and then read the voltage when the free side of the voltmeter is connected to the other side of the circuit where it is attached to the windings. Call this reading E. Then connect the same side of the meter to the frame of the generator, being careful to get a good contact. Call this reading E_1.

Then $$X = \frac{R(E - E_1)}{E_1}$$

where X equals the resistance of the insulation and R the resistance of the voltmeter.

The insulation resistance of a machine should be

considered as indicating little more than the condition of the insulation as regards moisture. The rate of change of the resistance as the drying proceeds is perhaps the best indication as to when the drying has been carried far enough. After the insulation resistance reaches a satisfactory value the machine should be brought slowly to normal voltage, held there for an hour or so, and then run up to the maximum voltage obtainable with full field current and held there for say five minutes. If no trouble develops the machine can be put under load.

There has been considerable discussion on the question of a high-potential test on a rewound machine. It is the writer's opinion that a severe high-potential test is not advisable. If the machine will stand full field voltage, it will give good service ninety-nine times out of one hundred. On the other hand, many an old machine may give years of satisfactory service when a double-voltage high-potential test would break down the majority of the coils.

If it is decided to give a high-potential test, be sure to get a testing transformer of sufficient capacity to hold up the testing voltage. A large armature may require a 35- or even a 50-kva. capacity testing transformer. Many a man has made a high-potential test with a 200-watt instrument transformer with apparently excellent results. He probably didn't have anywhere near normal voltage on the windings.

To my mind every high-potential strain shortens to some extent the life of the insulation. This may be very small for any particular case. You wouldn't put a double load on an old crane to see if it would fail, then why a double potential on an old high-voltage generator winding?

Largest Boiler To Supply Steam for Heating

By J. H. WALKER
Superintendent of Central Heating, Detroit Edison Company

Double-ended boiler having 29,820 sq.ft. of surface to supply saturated steam for heating at 75 to 160 lb. pressure. Volume of combustion chamber 11,440 cu.ft., or 0.383 cu.ft. per square foot of heating surface. Two 14-retort motor-driven underfeed stokers have fuel-burning capacity of 33,600 to 39,200 lb. of coal per hour, giving an allowance in furnace volume of 0.34 to 0.29 cu.ft. per pound of coal burned per hour.

AN INTERESTING saturated-steam boiler unit having 29,820 sq.ft. of steam-making surface is being installed in the Congress Street heating plant of the Detroit Edison Co. This is one of the four boiler plants that supply steam for heating buildings in the central business and residence district of the city. The continued growth of the central heating load has made necessary the addition of this unit which will raise the total boiler capacity in the four plants to 240,930 sq.ft. of surface. Outside of its size the new boiler unit is not a radical departure from existing designs, but has unusual features and refinements that should be of value from an operating and maintenance point of view.

A cross-section of the Connelly boiler unit is shown in Fig. 1. The four upper drums are 44 in. in diameter and the two mud drums 48 in. There are 2,184 tubes arranged in banks 52 tubes wide in the direction of the length of the drums.

Because of the closeness of the two center upper drums, no attempt was made to connect them with water-circulating tubes. Outside circulating pipe bends of 5-in. pipe diameter connect the ends of the drums, as shown. The boiler is designed for a working pressure of 160 lb. gage, but will be operated at present at 125 lb. pressure and at times as low as 75 lb., depending upon weather conditions.

The floor space occupied and the column spacings are nearly the same as for the 23,650-sq.ft. Delray boilers. The omission of the superheater (the central heating plants generate only saturated steam) made it possible to increase the amount of tube surface without changing the space occupied. A further increase in the number of tubes was made possible by the fact that the drums are rolled from a single sheet. The omission of the second longitudinal seam which would have been required had the drums been made up of two sheets, makes it possible to install tubes in the upper halves of the circumference of the mud drums. The result is that it has been possible to install 29,820 sq.ft. of heating surface in this boiler without a corresponding increase in the size and cost of the building, boiler setting, auxiliaries, etc. Naturally, the boiler becomes more efficient as there is more heating surface interposed in the path of the gases.

The boiler is set with the mud drums 15 ft. 9 in. above the floor, which is a common height for boilers of this type, giving a height to the extreme peak of the combustion chamber of approximately 35 ft. The volume of the combustion chamber, from the tubes to the top of the stoker tuyeres is 11,440 cu.ft., which reduces to 0.383 cu.ft. per square foot of heating surface.

As the boiler is double-ended, it is equipped with two underfeed stokers, three-plunger type, each having 14 retorts. The rated capacity is 1,200 to 1,400 lb. of coal per retort per hour, giving a total fuel-burning capacity of 33,600 to 39,200 lb. of coal per hour. The two stokers are driven separately by 10-hp. direct-current motors. Each clinker grinder also has its motor, independent of the stoker drive, thus allowing the speed of the clinker grinders to be adjusted without reference to the speed of the stoker—a desirable operating feature.

The stokers are driven through lineshafts in the usual manner. Each section, consisting of two or three retorts, has a two-speed clutch enabling the speed of any section to be reduced to one-half when necessary. This feature is expected to prove of considerable operating value by enabling the fireman to eliminate uneven spots in the fuel bed as they occur. The speed range of the stoker, including the additional range obtained from the two-speed clutches, is from 6 to 100 revolutions per hour. Beneath the stoker the floor is depressed and partly cut away, as shown in Fig. 1, to allow of easy access. Otherwise, with the stoker set at the usual

height above the boiler-room floor, the approach would be difficult.

The boiler setting is of solid firebrick excepting the upper portion of the fronts, which are of special design, consisting of a tile lining, silocel brick insulation and a steel casing. The end walls in a setting of this height usually require special treatment to overcome the tendency to fall inward. Sometimes this has been taken care of by giving the inner face of the wall a curvature with a vertical axis, forming a sort of horizontal arch. Also in some furnaces large sections of the end walls have been tied back by clamps and hangers around the individual blocks. In the present case there will be several horizontal rows of large blocks tied back to the steel framing. This is expected to hold back the walls effectively.

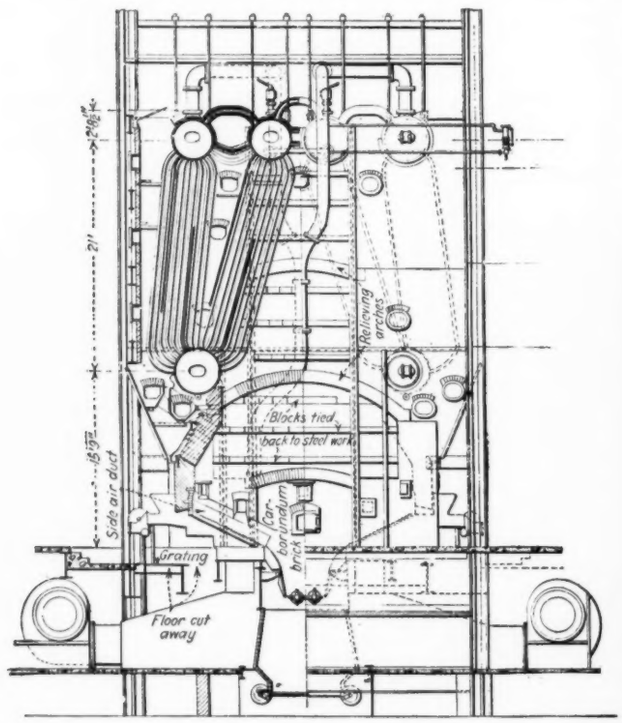

FIG. 1. DOUBLE-ENDED BOILER HAVING 29,820 SQ.FT. OF HEATING SURFACE BEING INSTALLED BY THE DETROIT EDISON CO.

To reduce the sticking of clinker to the side and front walls, a belt of carborundum brick approximately 18 in. high will encircle the furnace. This material is highly refractory and practically eliminates the adhesion of clinker to the walls, and also the difficult job of chipping off after a long run at heavy loads.

Owing to the service, the use of raw water to about 90 per cent of the total output will be required. To remove the scale-forming materials from the water, the boiler is equipped with four live-steam purifiers, each consisting of a drum containing a number of shallow pans over which the water flows. Each purifier is connected to the steam space of the boiler by a pipe of generous size, and the scale-forming materials in the water are deposited as the water becomes heated by the high-pressure steam. Before the water enters the purifiers, sodium carbonate is added in carefully graduated amounts. The purifiers are located above the boiler, so that the water flows from them by gravity to the boiler.

In the auxiliaries there is sufficient capacity to take care of all requirements up to 300 per cent of boiler rating. It is expected to attain this rate of driving after certain present difficulties of furnace maintenance and of the characteristics of the coal supply have been overcome.

Furnace air will be supplied by two motor-driven centrifugal blowers discharging into a large air chamber below the stokers. Access to this air chamber is gained by means of an air lock. The stack, which will eventually care for two boilers of the size given, is self-supporting, brick lined, and of approximately 17 ft. inside diameter and 225 ft. in height from the boiler-room floor.

Fig. 2 shows the type of control board to be used. It contains a steam-flow meter registering the boiler output, a CO_2 recorder, draft gages and damper-motor and fan-motor control. Regulation of the fire is by hand, there being no automatic regulators excepting on the feed water.

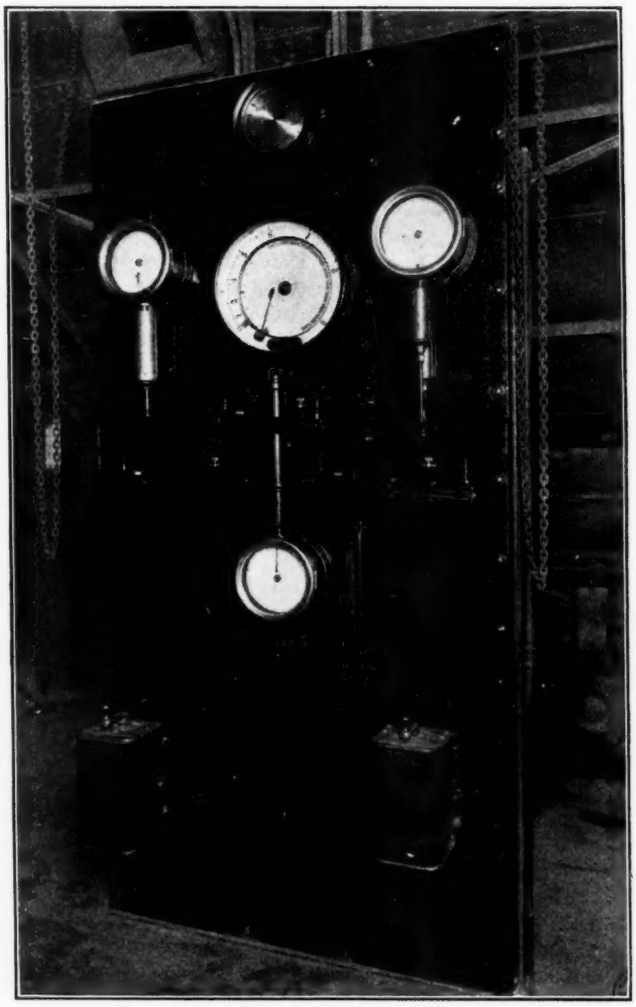

FIG. 2. CONTROL BOARD FOR THE BOILER

It will be seen that this unit, while not strikingly different from present practice, is nevertheless a step forward in saturated-steam boiler design. Its size, which is perhaps the largest yet attained, is the result of a natural alteration in the design of existing boilers to meet this special service. At the same time the efficiency has been improved and the investment per 10 sq.ft. of heating surface materially reduced.

Internal-Combustion Engines

Ignition Problems in Semi-Diesel and Diesel Oil Engines

BY CHARLES E. LUCKE*

THE injection oil engine, compared with the carburetor engine, introduces interesting thoughts. It makes engines independent of the grade of fuel; there is only one requirement besides its viscosity —cleanliness. The injection engine presupposes there will be under compression only air and that somewhere, whenever it suits the designer the fuel will be injected. This means that by properly choosing the time of injection, the compression may be as high as pleases the designer. Unlike the carburetor engine there is no longer any limit of temperature of ignition because there is nothing to ignite. As a consequence the injection engine has higher possibilities of efficiency, and those possibilities are attainable and attained. If the high compressions that correspond to really high efficiencies are used, there will necessarily be involved higher normal, or higher emergency maximum pressures, which would require an increase in the weight of the engine. The weight of the engine is measured by the maximum pressure, either normal or emergency, in relation to the mean, and excessive maximum pressures will constitute a bar, or limit to the use of excessive compressions. One may choose a very high compression for efficiency in one case, or in another case choose to abandon some of the possible efficiency and select a lower efficiency by lowering the compression in order to obtain a lighter engine—and both these things are being done.

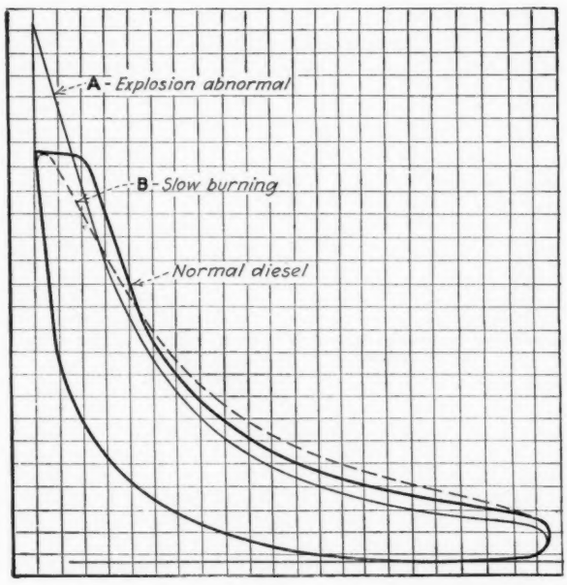

FIG. 1. INDICATOR DIAGRAM OF CONSTANT-PRESSURE ENGINE

Another difference found in the injection engine is the difficulty in making the fuel reach all the air. With the gas-burning engine and with the carburetor type using volatile liquid fuel, a mixture is made externally and every part is actively combustible, so that there will be the maximum possible work per cylinder charge for a given compression and shape of combustion line. With the injection engine there are certain real advantages, but if after compression of the air charge the fuel is thrown in too quickly, it will be difficult to reach all of that air in an unfavorably shaped combustion chamber. Injection engines differ from one another in the manner in which the fuel injection is directed to reach the mass of the air. That combustion chamber shapes must bear a proper relation to spray-nozzle design is a primary structural feature of injection engines.

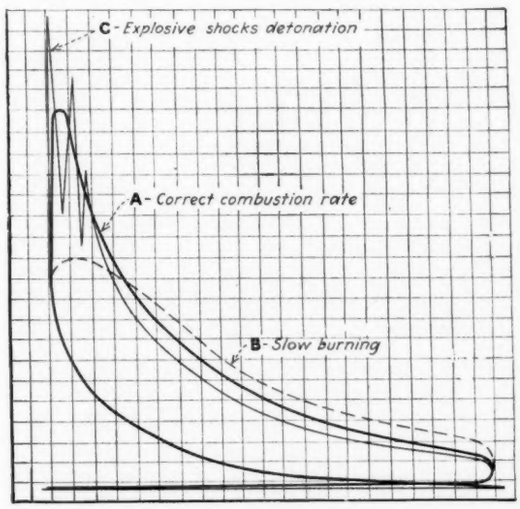

FIG. 2. INDICATOR DIAGRAM OF EXPLOSIVE ENGINE

There must be means of spraying the oil into a charge of dense air—air of a density up to 30 or 40 atmospheres; means of arranging to get the injected fuel in contact with as much of that air as possible, and means of preventing at any point any considerable amount of fuel that cannot reach air, because in that case there will be carbon deposited and smoke produced, which will choke up the engine in time.

The means of carrying out the operations that are peculiar to the injection engine are divisable, functionally considered, into two classes. The air must always be compressed. It may be compressed to ignition temperature and higher, so that the fuel as injected into it ignites immediately and burns as fast as it gets in, the rate of combustion being the rate of injection and being controlled by mechanical means. On the other hand, it may be compressed not to ignition, but to something less than ignition temperature, and then the fuel injected suddenly, to burn as nearly instantaneously as may be. That gives us two classes of injection engines, giving characteristic indicator diagrams.

The first one, shown in Fig. 1, carries the air to a high compression pressure, so as to have it not only as hot as the ignition temperature, but something higher. This would give a combustion at substantially constant pressure according to the full line, but if combustion is carried out imperfectly or deranged as to timing of injection or combustion, explosive shock might occur as at *A*, or slow burning as at *B*. The indicator

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diagram in Fig. 2 shows the cycle of the second class, combustion is explosive in type and, if imperfectly carried out, may result in explosive shocks shown at *C* or slow at *B* in dotted lines.

Each type is justifiable on the grounds of efficiency, power and practicability, so that the real problem boils down to one of mechanical questions of relative cost, reliability, foolproofness and adaptability to service conditions. The two are related in this simple manner as to efficiency. If the compression of the second with

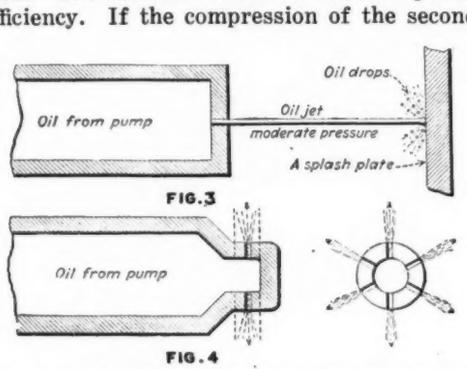


FIG. 3. HORNSBY-ACKROYD SPRAY NOZZLE
FIG. 4. MULTIPLE-ORIFICE NOZZLE

explosive-type combustion is about half the compression of the first burning the fuel at substantially constant pressure, their efficiencies are substantially the same. In the second case, if an explosive mixture is to be made, compression temperature must be kept a certain number of degrees (usually 100 deg. F.) below the ignition temperature of the fuel—this for fuel oil being about 1,070 deg. F., and with initial temperature of 300 deg., 150 lb. final compression pressure will be required. On the other hand, with the first type the final compression temperature must be considerably above the ignition point. For solid-injection sprays it is generally assumed that 200 deg. margin is safe and for air spraying 400 deg. For the latter case a compression of 450 lb. is pretty generally adopted and this will be secured with a little over 250 deg. initial temperature with kerosene and a little less than 250 deg. with fuel oil. Solid-injection ignition may be produced with equal reliability with less compression or with lower initial temperature, or both.

The first mechanical problem in connection with the injection engine is the problem of making the spray, and one might say, in a way, that the building of the engine begins with the forming of a chamber around a spray. The simplest way of making a spray nozzle, introduced by the first successful commercial engine which was brought here from England, the Hornsby-Ackroyd engine, was drilling a hole in a plate. It was so designed as to deliver a jet of oil unbroken, and with kerosene the jet looked like nothing so much as a silver wire. It didn't make any spray, but by placing a plate in line with it (Fig. 3) so the jet could strike the wall, a spray was formed by splashing. That is the simplest kind of spray ever made and more semi-Diesel engines are operating with such an elementary spray today than one might suspect. If the hole is reduced in size or if supplied with oil under much higher pressure, the oil will move more slowly on the sides and finally the entire jet will expand into a fine mist. If directed up into the air, such a spray would float the length of the room and look much like smoke.

The essential characteristic of such a spray is strong penetration power. That is important on account of the great density of the air, but in order that such a spray shall be able to reach all the air, the air should be arranged more or less in a narrow conical tube around the spray, but this is not ordinarily convenient. What is necessary, is some means of spreading. This can be secured by multiple holes, as in Fig. 4. Spread can be secured from a single spray orifice by giving the oil back of the orifice a rotary motion just as in the mechanical-atomizer oil burner as developed for the Navy (Fig. 5). Here, by locating oil grooves to deliver tangentially into a smaller chamber, the oil in the chamber will have a rotary motion and so also will the oil issuing from the end of the orifice at the outlet from the chamber. If the orifice has an area many times greater than the area through these grooves, there will be no residual pressure in the chamber, and in this case oil will issue in a hollow cone form, due to a pure centrifugal whirl. The spray will have a good and uniform spread with little or no penetration. If, however, the orifice is narrowed down so that it is smaller than the grooves in area, there will be residual pressure in the whirl chamber, producing axial velocity also, and the cone spray becomes narrower and solid. The spray will then have less spread and more penetration. This indicates that by comparatively simple design means the shape, the spread, the penetration and the fineness of a spray can be controlled within limits. In addition to this method of solid-injection spraying, which has some design features and is not a matter of pure haphazard invention, there is the air-spray system.

The air spray in its simplest form is secured as in Fig. 6. This is a cup with liquid fuel in the bottom, air above the fuel and a small hole in the side at or below the oil level. As the air escapes through the hole, there is a first depression of the liquid right at that point and the liquid is carried to the orifice by the air

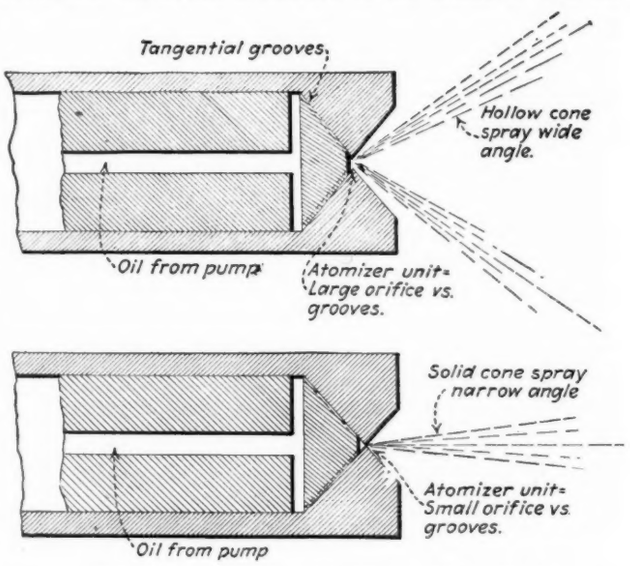

Tangential grooves
Hollow cone spray wide angle.
Oil from pump
Atomizer unit= Large orifice vs. grooves.
Solid cone spray narrow angle
Atomizer unit= Small orifice vs. grooves.
Oil from pump

FIG. 5. HOLLOW AND SOLID OIL SPRAY

flow across its surface and blown out, being sprayed by the higher velocity of the air. The quiet pool of oil has its surface disturbed by the air flow, friction carrying the oil gradually to the spray orifice. Such a spray is fine and has good penetration but not much spread.

A modification, giving somewhat better control, is shown in Fig. 7, which has a depression in the passage-

way at *A*, in which the fuel is deposited as a pool. The air in motion will tear the liquid from the surface, and this may be delivered to the cylinder in a narrow cone spray through a contracted orifice or through multiple orifices as at *B*, to get an adequate spread. This form is the so-called "open air spray" of the Diesel engine.

Next, there is the so-called "closed air-spray valve," in which a valve seats on the outlet of a passage, as in Fig. 8, separating the cavity from the cylinder. The oil is delivered by a pump into the passage and spreads out on plates that are usually arranged with holes or grooves or slots in them so as to offer a large amount of surface to be wetted by the oil. The air, which starts to flow as soon as the spray valve is opened by a cam, tears the oil off gradually and delivers it as a spray through a single or mutliple orifice as at *B* and *C*. Such a spray has a narrow angle, strong penetration and little spread except as may result from impact and rebounding. This is the most common air spray of the Diesel engine. To secure more spread directly, the valve can be reversed in seating, as in *A*, whereupon it will spray just the same, except that the angle of the spray is now widened, and it is a hollow cone instead of a solid cone, but with strong penetration.

For any given form of spray, air or solid, there must be a suitable combustion-chamber form, or for any given combustion-chamber form there must selected a spray of suitable shape or energy to best reach all the air, with always the possibility of setting up turbulence or internal air currents as a corrective means.

The first class of engines to be noted under the injection class is the one that is most successfully used commercially—the air-injection Diesel engine. Such

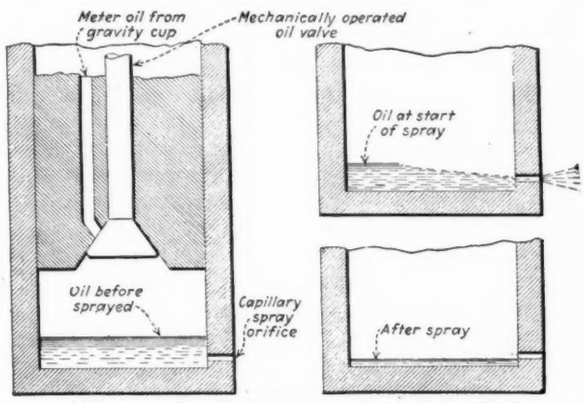


FIG. 6. CUP DESIGN OF SPRAY NOZZLE

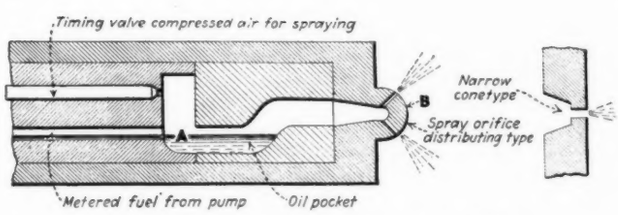


FIG. 7. DIESEL OPEN-SPRAY NOZZLE

engines are normally rated at 70 lb. brake mean effective pressure, but are capable of producing over 100 lb. if the metal can stand the intense heating. A fuel consumption of from 0.4 to 0.45 lb. per b.hp. per hour is standard. They are built in all sizes up to about 36 in. in diameter, depending on speed and mean pressure. The size is limited by the same internal heating conditions with tendency to crack the metal described as constituting the limit for large gas engines. The air-compression Diesel engine is in successful use for both stationary and marine purposes and has brought the internal-combustion engine into real competition with steam at sea, a matter of real importance which will be passed over as history.

Certain limitations of the air-injection Diesel en-

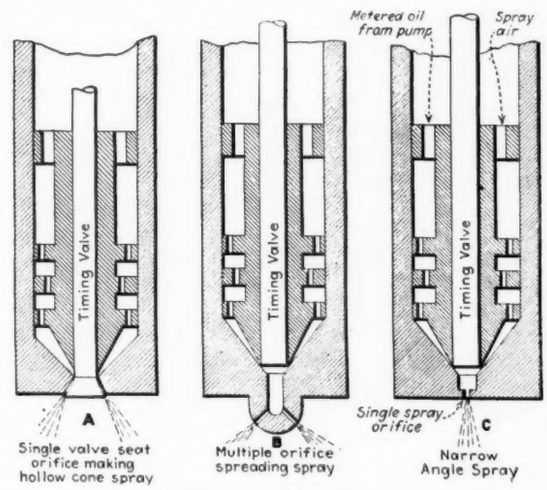


FIG. 8. DIESEL CLOSED-SPRAY NOZZLES

gine make it unsuitable for the problem just mentioned —the problem of the development of a substitute for the gasoline engine. It cannot be made to work in cylinders of small size without abnormally high compression, because of the cooling conditions that exist during compression, and in the size of cylinders that are just about its practical limit of smallness it is too expensive and too complicated. The control of the air spray is peculiarly delicate. The air for it must be provided by an attached air compressor, and it requires a pressure never less than 600 and often 1,200 to 1,500 lb. per sq.in. Such a compressor, small enough for the purpose of an automobile, is a mechanical absurdity. The air-injection Diesel, then, has earned for itself a place, but that place does not fill the entire field of possibility of the injection oil engine. The particular field to which it is not at all adapted, is the small-cylinder high-speed engine and that, in the internal-combustion market, is the biggest field of all. So it is clear why the problem of developing the small, and especially the high-speed injection oil engine, is a real problem and a modern problem—a problem of the present day, on which everybody is working more or less actively or is at least thinking about it.

To approach the problem of the small injection engine, what is available as a starting point? The nearest thing is a type of engine that has been on the market for some time and that is commonly known as semi-Diesel. This engine has a feature particularly attractive in the small-engine field—the feature of operating with so-called "solid injection or airless spray," eliminating the air compressor and the delicacy of adjustment of the air spray-valve system. It is simple, but in operativeness is not as perfect as the air-injection Diesel and is proverbially dirty-smoky, a condition that seems to be essential to the mode of operation. It has other peculiar characteristics that do not entirely com-

mend it and prevent its general adoption, and that have prompted a large number of people in both America and Europe to address themselves to the problem of making a solid-injection engine that shall have better characteristics. One feature of the semi-Diesel is hot metal, which plays in these engines the function of more or less vaporizing the fuel and also that of ignition. This hot metal, when an external wall, is always a fire risk. On a ship it may be serious and in many buildings is a dangerous piece of machinery. A hot-metal combustion chamber is practically an auxiliary pressure inclosing wall and thereby constitutes an element in some danger of breakage. The temperature of the hot metal is difficult to control within proper limits and sometimes impossible.

These semi-Diesel engines of hot-bulb, plate or tube pattern cannot be described in detail because of lack of space, but as one differs from another mainly by the hot-metal form, or location, and the combustion-chamber shape with reference to oil injection, a series of

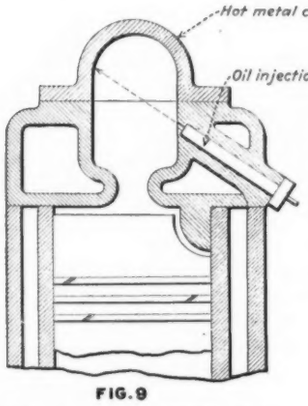


FIG. 9. HORNSBY-ACKROYD VAPORIZER

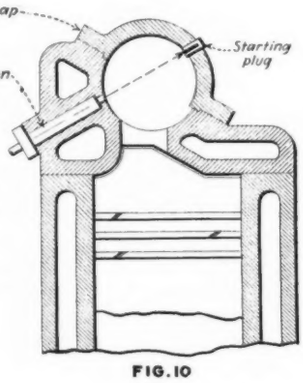


FIG. 10. VICKERS-PETTER COMBUSTION CHAMBER

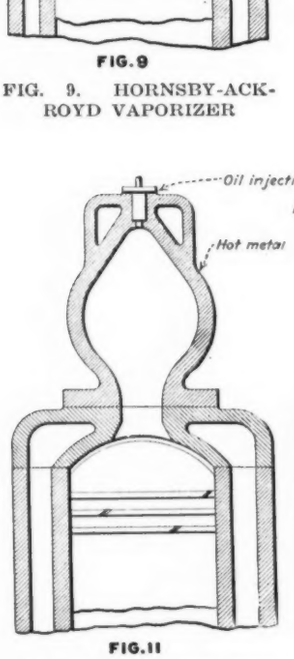


FIG. 11. AVANCE COMBUSTION CHAMBER

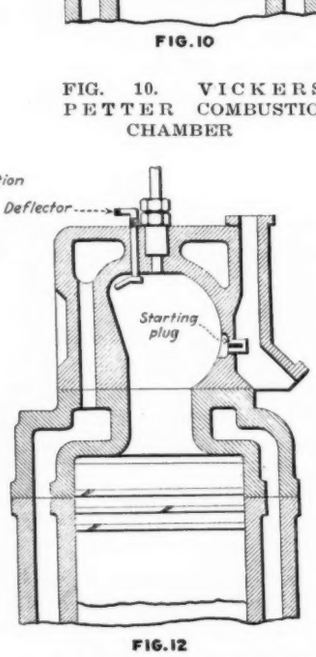


FIG. 12. FAIRBANKS-MORSE WATER-COOLED COMBUSTION CHAMBER

sketches of these parts will fix the structural characteristics of the class.

An unjacketed cap (Fig. 9) more or less hemispherical, closing a water-jacketed chamber connected to the cylinder by a neck, with an oil-injection nozzle arranged so that the jet strikes the hot cap, is typical of a group of engines that started with the Hornsby-Ackroid. If the oil injection is a solid kind of jet characteristic of the old Hornsby, ignition will take

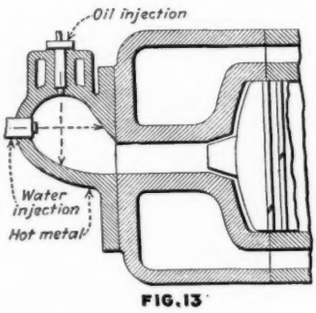


FIG. 13. RUSTON-PROCTOR COMBINATION CHAMBER

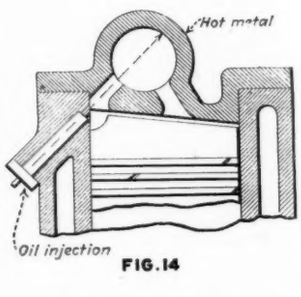


FIG. 14. BOLINDER COMBUSTION CHAMBER

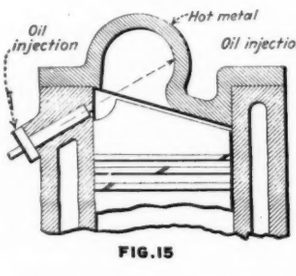


FIG. 15. CAMPBELL COMBUSTION CHAMBER

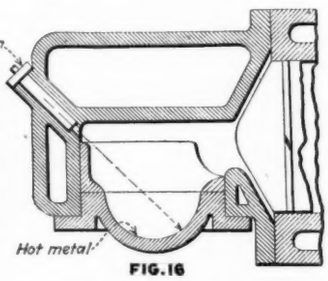


FIG. 16. DE LA VERGNE D. H. COMBUSTION CHAMBER

place only when the jet strikes the hot metal and the oil splash drops bounce off and become balls of flame. A lump of vapor will build up in the middle of each drop, with no air contact and no chance of reaching any air. This will make smoke and carbon will form where the jet strikes the wall, and the possibility of making all the fuel reach air to burn it is pretty nearly hopeless. The situation can be improved somewhat by making the jet spread, giving it less penetration perhaps, and more spread, or by subsequent mixing of air with unburned vapor or fog, and different designers of engines have attempted to develop correctors in various ways. All the engines belonging to this class depend upon contact of the fuel, either as a jet or as drops of oil, or as mixed fog and air, with red-hot metal to produce ignition. All face the difficulty of hot-metal temperature control. If the engine is running on light load, the metal may be so cold as to miss fire, or on full load get so hot as to cause preignition. Most are subject to burns or cracks in the hot metal unless the operator is skillful.

All these hot-metal wall or plate engines have combustion that is explosive in fact or in type. Combustion is explosive in fact when the air is charged with spray before any fuel reaches the hotwall where ignition takes place, inflaming the rest by propagation from particle to particle. This requires first, a fine spray that will remain suspended; second, a mixing of the spray with the air by spray spread alone or assisted by air currents induced by the shape of the chamber; third, air compressed to something less than ignition temperature; and fourth, all mixture made before ignition takes place. Combustion is explosive in type but not in fact, when fuel is injected very fast into air already compressed to or above ignition temperature,

burning as it enters at a rate substantially equal to a true explosion. It may also be secured by injection against a hot-metal wall without making a mixture, the rapid combustion naturally following the impact and ignition, about the same as if a fuel jet were directed into a fire.

As built, the Hornsby engine produced a mixture, the air current entering the bulb neck during compression mixed with the vapor from the jet which was injected during the suction stroke and vaporized in an atmosphere of products of combustion during compression. Ignition took place at the hot metal surface when compression of the mixture had reached about 40 lb. and combustion was explosive in fact.

In the modification, Fig. 10, as used in engines like the British Vickers-Petter, it might seem as if the only

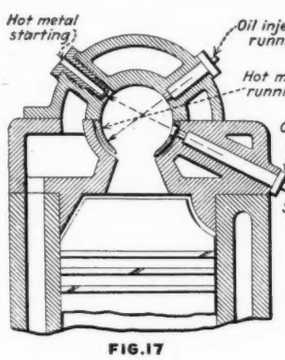


FIG. 17. KENT-NORRIS HOT-METAL IGNITION BOWL

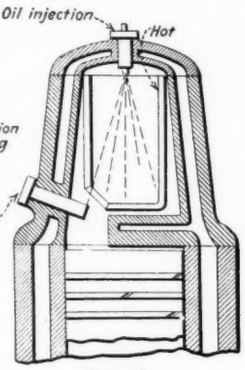


FIG. 18. CHICAGO PNEUMATIC TOOL CO. IGNITION DEVICE

change was in the shape of the chamber from cylindrical to spherical, with no change in functional action. As a matter of fact this is a late-injection engine, injection being timed by the pump to occur at the end of compression.

An effort to make the combustion chamber conform to the shape of a conical spreading spray is shown in Fig. 11, the Swedish Avance engine, which shape is pretty well retained by the Fairbanks-Morse engine, Fig. 12, though the latter has surrounded the hot conical chamber by a water jacket to reduce radiation and to help control metal temperature.

Substantially the same shape, but with a curved axis, is shown in Fig. 13, the old British Ruston-Proctor, which also shows a water-injection valve to control metal temperature. A change in shape, to give a different air-mixing action, is shown in Fig. 14, the Swedish Bolinder, this one requiring a narrow angle spray of non-spray splash because of the narrow passage, and is not at all adapted to a spreading spray. Still another change in air currents results when the neck between combustion chamber and cylinder is completely eliminated, as in the British Campbell, Fig. 15. In this case a spreading spray could be used, but there are practically no air currents to induce mixture making with the spray. This same situation, as to the availability of spreading spray, is found in the American Doelling-De La Vergne construction of Fig. 16, which, however, does retain the cylinder neck as a mixing means. The idea of inclosing the hot metal completely is shown by the British Kent-Norris construction of Fig. 17 and by the American Chicago Pneumatic of Fig. 18.

File for Magazine Clippings

By John S. Carpenter

After failing many times to find magazine clippings with a bearing on power-plant matters under consideration, a certain engineer put up a notice in his office reading: "A ten-dollar bill will be presented for the best method of filing and indexing magazine clippings. Remember that a given page sometimes has two or three subjects . . ."

About six different plans were submitted and I got the ten-dollar bill. Having worked in a number of branches and being interested in many subjects, and with something like 7,500 pages of magazine clippings in English, French and German to care for, an index and file becomes a problem—the more so when more than one subject appears on a page. To preserve full magazines takes too much space.

The system is to number the clippings consecutively and put them in batches of about fifty pages in large manilla envelopes which open on the side. All these envelopes are marked, showing what clipping numbers they contain. A four-drawer vertical filing case provides room for future expansion, 7,500 clippings filling it about to half capacity. Guide cards in the vertical file locate numbers in intervals of 200. In this way there is no sequence of numbers to be broken up by the addition of future matter.

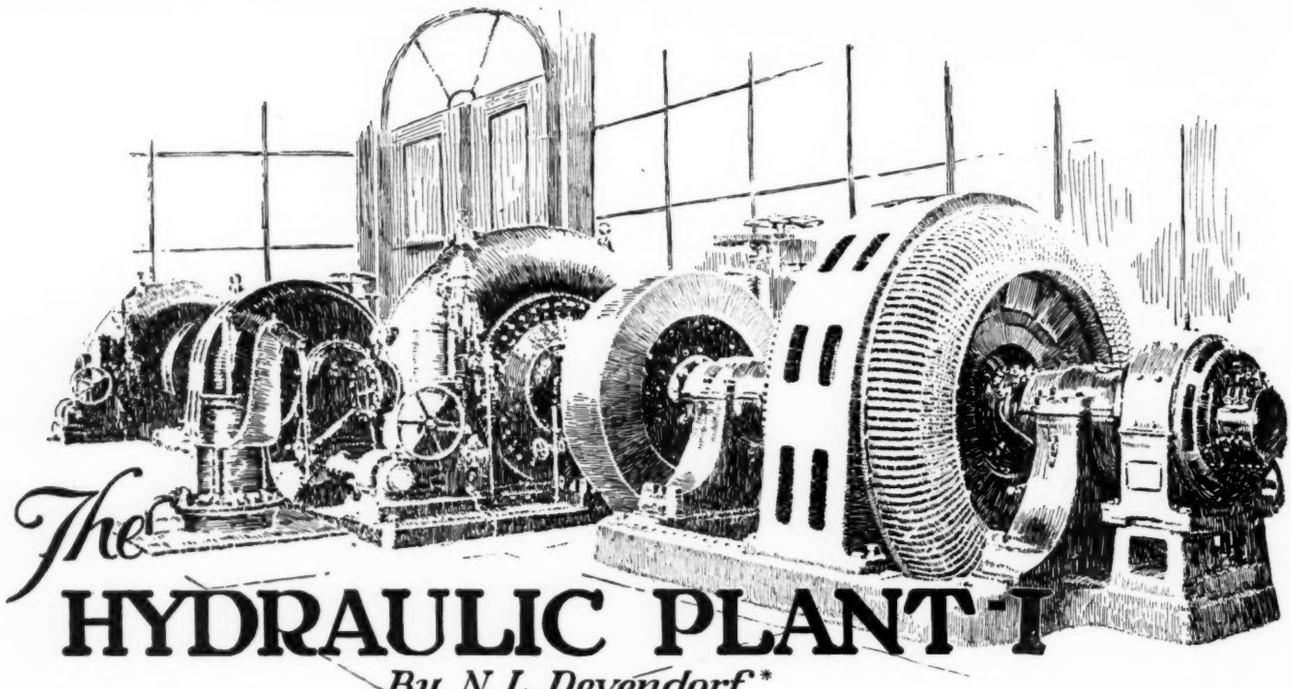
For the index, use 3 x 5-in. cards in alphabetical order. For instance, under C come Concrete and by using guide cards of another color, subdivide as follows: Concrete Buildings, Concrete Coal Bunkers, Concrete Tanks, etc. Under T comes Turbines, both steam and water turbines. The subject Turbines-Water, is subdivided, Runner Design, Draft Tube Design, Notable Installations, etc. Under P would come Power Plants, subdivided into Ash Handling Systems, Coal Towers, Coal Storage, Electrical Features, etc. A given clipping is indexed thus:

"Hydro-Electric Practice—Draft Tube Design. By C. Voetsch, *Power*, Aug. 2, '21. Clipping 4,156.

This article happens to lap over another page which contains an interesting article, "Gas Engine Troubles," which would be similarly indexed with the same clipping number under Gas—Gas Engines.

In some filing methods the article would be filed under a general subject index "Hydro-Electric Practice," and should one later wish to locate the article on gas-engine troubles, it very probably could not be found, or only by going over the whole file. In the method suggested, no article of interest need be overlooked.

Commenting upon the explanation that faulty insulation caused the great fire at the army piers in Hoboken, N. J., when the "Leviathan" was endangered, an editorial in the N. Y. *Herald* concludes: "It was once popular to attribute all fires of mysterious origin to the act of God. Later, spontaneous combustion came into official favor as a cause of fires, but when it was realized that this commonly meant gross carelessness in handling wastes, it lost some of its popularity. Now incendiarism and faulty insulation are the refuges of those who make official guesses to explain conflagrations. As soon as it is generally understood that faulty insulation spells culpable neglect, it is to be expected this phrase will be laid aside."



The HYDRAULIC PLANT—I

By N. L. Devendorf*

Methods of removing débris from water in high- and low-head plants, types of hydraulic turbine employed, their limitations and the means for effecting regulation.

IN PREVIOUS articles the preliminaries to the production of hydraulic power were discussed up to the point where the water enters the wheelpit or penstock prepared to perform useful work and earn money. Before the water may be allowed to enter the wheelpit, it must be free from solid bodies that might clog up or damage the turbine mechanism. To this end racks or screens are installed, in the low-head open-wheelpit type of construction at the point where the water enters the wheelpit, and in the closed-penstock type at the entrance to the penstock or pipe line. Floating logs, sticks, ice, leaves, masses of aquatic plants and other débris are found in most streams to some extent, especially in those passing through thickly populated sections.

It is a matter of observation that the fewer inhabitants along the banks of a stream the less rubbish and débris, natural or artificial, will find its way to the racks of the power plant, so that in many developments in the more remote sections there is little beyond a small amount of floodwood, and possibly some leaves in the fall, to be screened out; but the racks are necessary even in the cleanest streams, as a log or stick might do considerable damage if it were permitted to enter the wheelpit

In the case of high-head developments, where impulse turbines are installed, care must be exercised in this respect, as a small object that might do no harm in the more open construction of the reaction turbine, might become wedged in the small nozzle through which the water is fed to the impulse turbine, and not only shut off the water supply to the turbine, but, by reason of the sudden stoppage of the water column, bring about pressures and strains that might cause serious damage to the pipe line and turbine setting.

In these high-head plants the water is first passed through a settling basin, where suspended sand and silt settle to the bottom, later to be disposed of by special sluiceways provided for the purpose. Then in many of these developments the water passes through revolving screens, one type of which consists of a strong wire screen of about ½-in. mesh which is drawn slowly upward out of the water by means of motor-driven sprockets. The débris is carried over the upper sprockets and is then washed into a trough by a number of water jets playing on it through the screen. The screens in this type of plant are located necessarily at the intake to the pipe line and often at a considerable distance from the plant.

In the low-head plant the racks consist of flat steel bars set on edge vertically, the top being inclined downstream. Though in some cases mechanical devices have been proposed for cleaning them, ordinarily they are raked by hand, and in some sections it is necessary to do this several times a day and to have means for the ready disposal of the rubbish, that accumulates, especially if the plant is downstream from a large town.

Reaction Turbines

There are two types of hydraulic prime movers in general use at the present time—reaction and impulse turbines. The reaction turbine is installed generally in developments of low and medium head, up to 300 or 600 ft., and occasionally over 800 ft. The impulse turbine is generally adapted to the higher heads and is in use in developments where the head is from 200 to 2,000 ft. or more, with the high-head limit as yet unattained. While each of these types has its sepcial field, there is no hard and fast line of division between them, and they overlap to a considerable extent. The choice of turbine is governed by the special conditions found in each case.

*Instruction department, Consumers Power Co.

but it is safe to say that outside of a wide use of the impulse turbine in the mountainous regions of the West, where the heads are high and the flow small, the majority of hydro-electric plants are equipped with reaction turbines.

The reaction turbine consists esentially of two sets of vanes or blades, one of which is mounted on a shaft and revolves, while the other set is stationary with respect to the moving element; but in most modern makes these latter vanes are pivoted, and by mechanical connection through a cast-iron lever or link from each vane to the operating ring, and thence to the gate rigging and governor, are used as gates to control the flow of water into the revolving element or runner. In some of the older types the gide vanes are rigid, control of the flow being obtained by means of a cylinder that slides between the two sets of vanes, its position determining the area of the passage into the runner. This cylinder is operated by rack and pinions driven by a shaft from the governor or hand control, or by direct connection to rods connected to the control mechanism outside the turbine case or pit. The movable guide vanes are called "wicket gates" and are generally operated by a shaft that is rotated through part of a revolution by the governor, with connecting rods from it to the operating ring. The efficient angle of the gates or guides, and the curve of the vanes of the runner, as determined by many years of experiment and test, are accurately laid out and the result is a prime mover having an efficiency of from 80 to 90 per cent.

Gates or guides and the curved vanes of the runner are so arranged that the water, in passing from the one to the other, must change its direction of flow. This obstructs its free passage and tends to reduce its

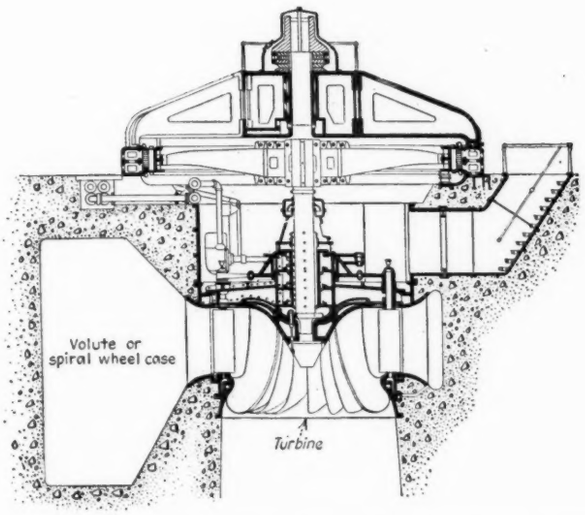


FIG. 1. TYPICAL MODERN VERTICAL TURBINE UNIT

velocity, which is thereby transformed into pressure, producing a heavy thrust against the vanes of the runner. Further obstruction to the free passage of the water is found in the continued change in the direction of the curve of the vanes, so that as the water slides along them its remaining velocity is transformed into pressure, imparting additional thrust to the moving vanes, until it leaves the runner at low velocity, with the greater part of its energy absorbed by the runner and transformed into a useful form of mechanical energy in the revolving turbine shaft.

In the reaction turbine the passages between the wheel vanes are always filled with water, so that all the vanes are working all the time, and the flow is said to be continuous. The forces that act on the turbine are,

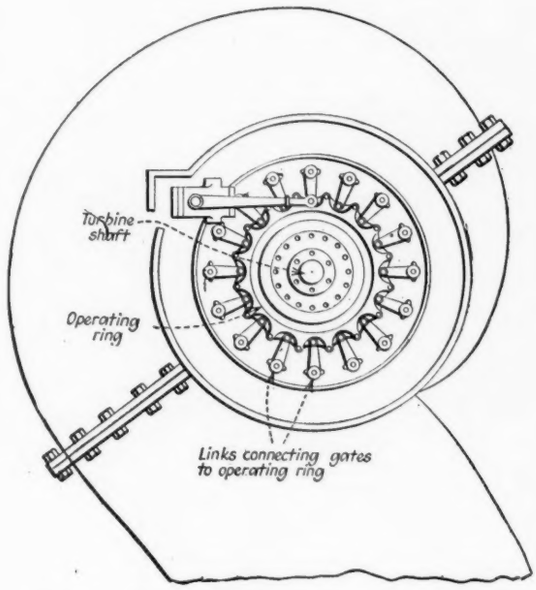


FIG. 2. GATE MECHANISM OF A MODERN REACTION TURBINE

first, a certain amount of static pressure due to the weight and velocity of the water column, and second, the reaction whereby the velocity of the water column is changed into pressure due to the change in the direction of flow as it enters and passes through the runner, following the curve of the vanes. The latter of these forces is the greater.

IMPULSE TURBINES

In the impulse turbine the stationary part is a nozzle which may have one of three forms: (1) The hand-regulated needle nozzle with a deflecting hood; (2) the hand-regulated deflecting needle nozzle, and (3) the double-needle nozzle, one of the openings of which directs the jet onto the buckets of the runner, and the other discharges into the tailrace. The runner consists of a circular disk to the rim of which are rigidly attached a number of cup-shaped buckets, the insides of which are of a peculiarly curved shape, carefully and accurately designed to eliminate foam and eddies in the bottom of the cup. The jet is split in halves by a sharp wedge in the center of the bucket, so that it discharges equally on either side. If the speed of the runner is correctly proportioned to that of the jet—that is, if the buckets of the runner travel at about half the velocity of the water—the abrupt reversal of direction of the jet as it strikes the bucket will impart to the bucket the entire kinetic energy of the water, and the discharge is at practically zero velocity as it leaves the turbine, giving an efficiency of 80 to 87 per cent.

In an impulse turbine the nozzle is equipped with a needle valve by which the jet may be reduced from a solid bar of water to a thin tube, with proportional alteration of its effective thrust. This valve must be operated slowly, or pressures and strains of formidable,

perhaps destructive, proportions may be set up in the penstock or pipe line. The higher the head and the greater the length and diameter of the pipe line, the higher these values. This would make satisfactory regulation of an electrical load impossible, as the demands of many classes of service are decidedly intermittent. As has been stated, close regulation, without sudden variation of the velocity of the water column, is accomplished in one of three ways.

The needle nozzle may be manually operated in connection with a deflecting hood which, on increase of speed, cuts off the jet and deflects it from the buckets by direct action of the governor, to which it is connected by suitable levers. When the speed drops below normal, the governor raises the hood and the jet again impinges upon the buckets. For efficient operation the needle valve should be kept at the point where the maximum load may just be carried, and so far as possible the load should be steady, or at least not subject to rapid variations.

In the second method of control the connection to the pipe line is by means of a ball-and-socket joint, which permits the nozzle to be moved vertically, and this is accomplished by connection of the nozzle to the governor in the same manner as the deflecting hood is connected in the first instance.

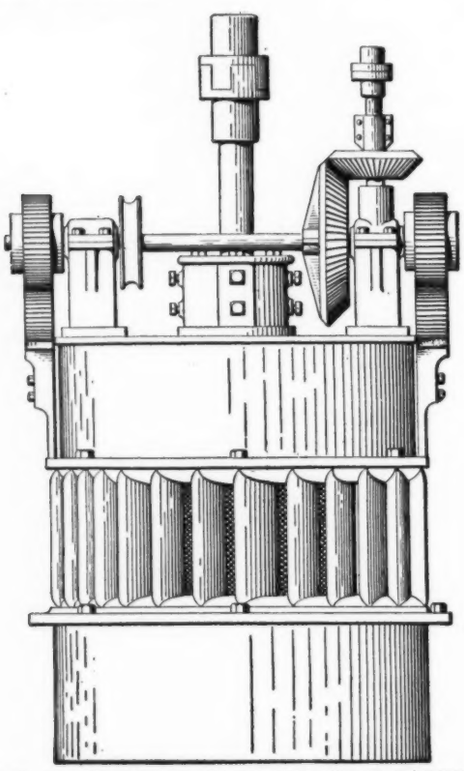


FIG. 3. CYLINDER GATE REACTION TURBINE

In the third case one of two nozzles is rigidly set to impinge upon the buckets, while the other discharges into the tailrace. This type regulates by adjustment of the needle valves direct, the one being closed as the other opens, both being positively connected to the governor. In all cases the maximum load adjustment may be controlled by direct hand operation of the valve or by remote control by means of a motor operated from the switchboard. In the third type the setting of the relief valve may be adjusted automatically by means of relays, dashpot and other auxiliary equipment, so that it will open or close slowly on an increase or reduction of load after the working jet has adjusted itself to the changed condition.

It is important to keep the discharge at the correct value for the load carried, as otherwise water will be

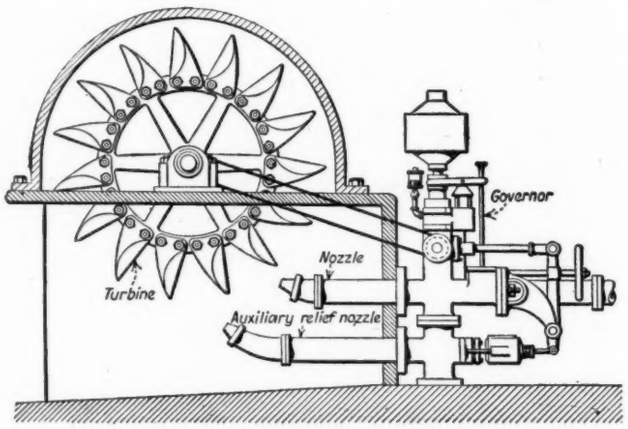


FIG. 4. IMPULSE TURBINE WITH AUXILIARY RELIEF VALVE

wasted, and in the semi-arid mountainous regions where this equipment is largely used the streams have but a meager flow, though in many developments a large amount of power is generated from them, owing to the high heads available. But in the effort to save water, the water column cannot be started or stopped abruptly. A quick stop would be much like trying to stop a freight train on a down grade by turning it into a siding that ended in a solid wall of rock instead of slowing it down by a gradual application of the brakes.

Determining the Size of Drip Pipe

BY H. BLOMGREN

A question often arises in the designing departments as well as in the steam plant itself as to what should be the size of drip pipe necessary for a certain size main. It is impossible to determine by computation the size of drip pipes necessary for conveying the water of condensation from a certain size main, as the amount of condensation depends upon a number of conditions concerning which there is much uncertainty. Some of the conditions are, amount of moisture carried over by the steam from the boiler, steam pressure, steam velocity, length of steam main, quality and thickness of pipe covering and the temperature of the surrounding air, etc.

Water of condensation, unless thoroughly removed from the steam main, is a source of danger to the engines and equipment, and causes water hammer and leaky joints in the piping. The following sizes of drip pipes are ample for usual conditions and have worked out satisfactorily in practice:

Diameter of Steam Main in Inches	Length of Steam Main in Feet: 0–100	100–200	200–400	400–600
	Diameter of Drip Pipe in Inches			
0–2	¾	¾	1	1
3	¾	1	1	1¼
4	1	1	1¼	1¼
5	1	1¼	1¼	1½
6	1	1¼	1½	1½

The drip pipe from throttle valves is ordinarily made one-half inch in diameter irrespective of the size of steam pipe; this is also true in the case of steam-chest drip.

Selection of Brushes for Power-Plant Equipment

Different Grades of Brushes and Their Composition—Kinds of Brushes for Low-Speed and High-Speed Generators, for Motor, Rotary-Converter and for Slip-Ring Applications

By WARREN C. KALB
General Manager, Corliss Carbon Co

IN THE selection of brushes for various applications, operating engineers have frequently been told that they do not possess the necessary information on which to base their selection, and that if they wish to obtain satisfactory brush operation they must refer their problems to the engineering staff of the brush manufacturer. It is true that certain lines of special information are required in order to make the best selection, and there may be unusual conditions at times, requiring the services of a specialist who has given extensive study to brush application. However, if the operating engineer informs himself in regard to certain fundamental factors that need be considered, he will be able to select suitable grades for all normal applications. It is the purpose of this article to outline some of the information needed in determining the type of brush to be applied in any given case.

Carbon-Graphite Brushes

Practically all of the older types of carbon brushes and many of the grades manufactured today fall within the class known as the carbon-graphite grades. These brushes are manufactured from a mixture of amorphous carbon with the desired percentage of graphite. The amorphous carbon is usually in the form of coke ground to a very fine flour. The graphite may be natural or artificial, depending on the characteristics desired in the finished product. Brushes of this class, after being given the desired form either by extrusion process or by molding in dies, are baked in kilns, usually gas-fired, to a point that thoroughly carbonizes the binding agent. A wide range of physical characteristics is found in brushes of this class. Some possess very little abrasive property, while others are decidedly abrasive in their action. The least abrasive may be used on commutators with undercut mica, but the class in general is intended for use on flush mica. Brushes of this class as a rule are not intended for operation at high peripheral speeds, few grades being recommended for speeds above 4,000 ft. per min. and most of them restricted to lower speeds. This class of brushes is extensively used on industrial motors and non-interpole generating equipment, particularly types operating at relatively low commutator speed. Certain grades may be recommended for speeds above 4,000 ft. per min. in cases where operating conditions make it impracticable to undercut the mica of the commutator.

Some brushes of this class are impregnated with a lubricating material in the nature of an oil or wax. This practice, however, is not recommended by most engineers. While it temporarily reduces the friction and improves commutating properties of the brush, this improvement is not always permanent. Frequently, the temperature encountered at the contact face of the brush is sufficient to drive out this artificial lubricant, leaving the carbon in its original condition and leading to the development of trouble not apparent when the brushes were first installed. Brushes without such lubricating treatment and having permanent physical characteristics are available for all classes of service.

Electro-Graphitic Brushes

Some of the best grades of brushes manufactured today are given a final heat treatment at a very high temperature in an electric furnace. This tends to volatilize the impurities within the brush and convert a portion of the carbon from the amorphous to the graphitic form. Most brushes in this class are non-abrasive, and for this reason electro-graphitic brushes should be used with undercut mica unless commutating conditions are so nearly perfect that there is no tendency for the mica to become high. Such brushes are manufactured over a wide range of resistance, and grades may be found adapted to nearly all classes of service over the full range of standard voltages.

In recent years brushes in the electro-graphitic class, possessing very low electrical resistance, have been developed for use on slip rings. They are well adapted for alternator-field rings, induction-motor slip rings and even for the alternating-current side of rotary converters of considerable capacity. In the latter application the limiting factor is temperature rise due to the relatively high contact drop of this type of brush when compared with metal-graphite brushes. Successful applications have been made on 600-volt rotaries as large as 2,000 kw. Most electro-graphitic brushes possess a low coefficient of friction, making them applicable to the higher peripheral speeds.

Graphite Brushes

Most brushes in the class defined as graphite contain nothing but natural graphite, carefully selected for its freedom from impurity, and the required binding agent. In certain grades a small percentage of metal, usually copper, may be added to give the brush a mild abrasive or cleaning action. Brushes of this class are designed for very high peripheral speeds and current densities. Their principal field of application is on high-amperage, high-speed generating equipment, but they are also used to a moderate extent on slip-ring service. Owing to their softness and low mechanical strength brushes of this type will not stand up under severe mechanical conditions. The mica of the commutator should be undercut when graphite brushes are used unless experience has shown that the abrasive action of the grade in ques- is sufficient to prevent any tendency toward high mica.

Metal-Graphite Brushes

Metal-graphite brushes are made from a mixture of copper powder and graphite in various proportions. In some grades small percentages of other metals, such as tin, lead or zinc, may be included in the mixture. The carrying capacity of brushes of this type is very high and the contact drop low. They are applied to conditions

where one or both of these characteristics is an essential feature. Their principal application in power-plant equipment will be found on slip-ring service, particularly on the alternating-current side of large converters.

Gauze and Copper-Leaf Brushes

The slip rings of many of the older types of machines are equipped with brushes manufactured from metallic gauze or thin strips of copper. The tendency of this type of brush to score the rings has resulted in its elimination from most machines of modern design, metal-graphite brushes having been found much more satisfactory. In most cases the brush-holder construction used with gauze or copper-leaf brushes depends on the flexibility of the brush itself for maintaining firm contact between brush and ring. For this reason it is seldom possible to substitute metal-graphite brushes in the same holders used for gauze or copper leaf. The advantages of the metal-graphite brush, however, frequently make it economical to install a different type of brush-holder adapted to the use of inflexible metal-graphite brush.

Direct-Current Generators and Motors

Direct-current generators of high peripheral speed should be equipped with electro-graphitic or graphite brushes and should have the mica of the commutator undercut. Where special conditions make it necessary to operate with flush mica, the same types of brushes may be used if commutation is very good. Should there be any tendency toward high mica, however, it will be necessary to use one of the carbon-graphite grades adapted to high peripheral speeds.

Best results will be obtained on slow-speed generators by the use of electro-graphitic brushes with undercut mica. In case the mica is left flush, carbon-graphite brushes are to be preferred.

Direct-current motors used for fans, pumps, compressors, etc., should be equipped with electro-graphitic brushes where the mica is undercut and with carbon-graphite brushes on flush mica. Crane and hoist motors, being of the series type and possessing poorer commutating characteristics in general than motors of the constant-speed type, will require relatively hard grades of electro-graphitic brushes for undercut commutators and somewhat abrasive carbon-graphite brushes for flush mica.

Rotary Converters

Selection of brushes for the direct-current side of rotary converters should be made on the same basis as for high-speed direct-current generators. For the alternating-current side metal-graphite brushes will be used in most cases, although certain grades of electro-graphitic brushes are now coming into use on rotaries of moderate capacity. Gauze and copper-leaf brushes are not recommended unless the brush-holder equipment is not adapted to another type of brush. In such cases, as has been previously stated, it is often advisable to change the type of brush-holder to permit the use of a metal-graphite or electro-graphitic brush.

Alternating-Current Generators

For the field rings of alternators the type of brush required will be determined largely by the peripheral speed. Where this speed is low, carbon-graphite brushes have been used successfully, although electro-graphitic brushes are to be given preference, provided no abrasive action is needed to overcome a tendency for spots to form on the rings. On rings with high peripheral speed such as are frequently encountered on turbine-driven alternators, graphite brushes have the most extensive application, while electro-graphitic brushes are often used with good success.

Synchronous and Induction Motors

Selection of brushes for the field rings of synchronous motors will be determined by the rules for alternators.

For the slip rings of induction motors the selection of brushes is usually determined by the carrying capacity required, peripheral speed seldom being high enough to become a deciding factor. Electro-graphitic, graphite and metal-graphite brushes are all used on this class of machines, and the proper type may be determined either by calculation of the current density in the brushes or by observation of the type originally supplied by the manufacturer.

General Considerations

Having informed himself as to the meaning and influence on operation of the various physical characteristics of brushes, the general characteristics of each class of brush and the classes adapted to different types of machines, the operator desiring to select a grade for a given application should first determine the general class of brush best adapted to the service in question. The points to be considered in reaching this conclusion are the general type of machine, whether the brush is for use on commutator or slip rings and the degree of abrasiveness required. The latter point will be determined to a large extent for commutating machines by the commutating characteristics of the machine and whether or not the mica of the commutator is undercut.

Having determined the class of brush required, the physical characteristics should next be considered in the following order:

Select for preliminary consideration only grades having a rated carrying capacity equal to or greater than the current density in the brushes at the rated load of the machine. In case the machine is to be operated at overloads for extended periods, allowance should be made for these overloads. If the service is intermittent, such as that of crane and hoist motors, the manufacturer's rated carrying capacity for continuous service may be increased 25 to 50 per cent.

Of the grades possessing sufficient carrying capacity, only those should be considered that are recommended for peripheral speeds as great as or greater than that of the commutator or ring on which the application is to be made. It should be borne in mind, however, that on slip-ring service it is permissible to allow speeds of 20 to 50 per cent higher than the manufacturer's rating for commutation service.

The next point to be considered in selecting brushes for use on commutators is the commutating characteristics of the machine. Where this is not of the best, the grade should be chosen having the highest contact drop given by the manufacturers of those meeting the foregoing requirements of carrying capacity and peripheral speed.

Careful consideration of the factors here named and analysis of the problem of selection in line with the outline given, will enable the operating engineer to select a grade of brush well adapted to any of his equipment of standard design and operating under what may be considered normal conditions.

Power-Plant Accounts—III. Use of Journal and Ledger (Continued)

By WILFRED A. MILLER

THE first requisite in the determination of any cost, be it that of power generated or any other, is to have a properly designed system for the recording of all facts that enter into the cost, and the second is that the facts be correctly gathered and entered in the records. Ordinarily, this process may be said to consist of making memoranda of all the factors day by day as they occur, and combining them periodically into groups of a like nature. The daily facts may be entered in any memorandum book, which thus becomes a "journal" of detailed information. In order to separate out and combine items of the same class, we may set aside a second blank book and in it use a page (or a number of pages) for each class of item. Then, by transcribing or "posting" the entries from our journal to the proper pages in the other book—the "ledger"—we automatically gather all items of the same kind together. At the end of a certain period of time we add together all the postings on each page or "account" of the ledger to find the total for the period. The period usually covered is, it is hardly necessary to state, the month. That is, we keep making journal entries and posting them to the ledger for a month, and then, at the end of the month, when it is certain that everything is noted that should be, we add up each ledger account. To find the grand total cost of generating power for the month, it is merely necessary to add together all the individual ledger accounts.

> This is the third of a series of articles written in conversational style and treating the subject of power plant accounts in a thorough yet extremely simple manner. They were prepared primarily for the guidance of the operating engineer who wants to keep track of the cost of the power he is making but who knows nothing at all about bookkeeping. Others may find these articles helpful in clearing up their ideas on the subject. This installment starts by reviewing part of what has gone before and then takes up the following: Difference between repairs and investment; improved form of journal page; examples illustrating use of ledger; checking the total cost.

A convenient classification of accounts is the following: (1) labor; (2) fuel; (3) water; (4) lubricants; (5) ash removal; (6) repairs; (7) scale removal; (8) miscellaneous supplies; (9) investment.

The first eight of these accounts need little discussion; they are all quite apparently direct items of expense chargeable to the generation of power. The ninth, "Investment," is however, of a very different nature. Really, it should not be listed as one of the elements of cost at all, but we will leave it where it is for the present, for reasons that will be given presently.

To illustrate the fundamental difference between what we may call an expense item, such as Labor, Fuel, Repairs, and the like, and an Investment item, let us assume that we have an old pump that requires repacking often, say once a month, and that we go out and buy the packing every time we need it. When we come to enter such a purchase in the journal, we will quite naturally charge it to the Repairs account. There is no question but that the packing is used up during the month and that it is therefore an element of the cost of generating power during that month. Suppose now, that the old pump gives so much trouble and costs so much for repairs that we decide it will be more economical to scrap it and buy a new one in its place. We carry out this decision and in due course the new pump arrives and is installed. Here then, is an entry for the journal, but under what class shall we place it? Will it fit in any of the first eight in the list? Evidently not; nor should it do so, for whatever items we put into any of these classes become a part of the cost of power for the month. Now certainly the new pump in not going to be used up in a month as was the packing in the old pump. Nor will it be used up in a year, nor in five years for that matter. Consequently, it would be a gross error to charge it in as an expense for the month. It is, in fact, an investment and must be regarded as such. To take care of investment items such as the foregoing, an Investment account has been included among the other accounts in the ledger. It should, however, be very thoroughly understood that this account must not be added in as an expense. Thus, at the end of the month, when we wish to find out the total cost of power for the month, we add together the totals of all the accounts *except* the Investment account. That is left to stand by itself; its total merely tells us how much we have spent for new equipment. In the preceding illustration there was a very clear-cut difference between Repairs and Investment. The difference is not always so distinctive. One of the most troublesome questions of this kind arises in the replacing of worn or broken parts. Shall the replacement be charged to Repairs or to Investment? It is sometimes difficult to decide. If the part is small and likely to wear, it is properly chargeable to Repairs. If, on the other hand, the replacement is of an extraordinary nature, such as, for example, taking out the cylinder of an engine and putting in a new one, the charge should certainly be to Investment. As already stated, the method of disposing of such items is a matter of judgment; no hard and fast rules can be laid down.

The subject of investments has been taken up at this time only to bring out the foregoing fact, so that we may be sure not to include in the cost of power any items that should not be charged to it. We will now put it aside for the time being, until we have progressed further in the development of the system of records, when we shall find that we must give it more attention than is necessary just now.

To come back to the journal and ledger, which form the basis of all the records, we find that the journal is merely a memorandum book and the ledger a summary of the entries in the journal. If we care to start out with ordinary blankbooks, we may rule columns in

them as shown in Fig. 1 and 2, the former being an improved-form journal page and the latter the ledger page. It will be noted that this journal page has two "Amount" columns, one Left and one Right, whereas the one previously described had only one "Amount" column. We could readily get along with one column only, but the two columns are a convenience in this way: There may be some items to enter in our journal which represent payments *to* us instead of payments made by us. For example, we might be able to sell our ashes to some contractor. In that case we would have to distinguish those entries in the journal in some way so that instead of adding them in as an expense we would subtract them from the expenscs. If only one "Amount" column were used, we could accomplish this identification by using a red pencil to make the entry. By using two "Amount" columns in our journal, we get away from using any such contrivance. What we can do then is to use the left column for amounts that we pay out and the right column for those that we receive. Should we then at any time wish to know the total expense on any journal page, we need merely add the left column, then the right one, and subtract the right from the left. If only one column were used, it would be necessary to pick out all the expense items and add them together, then pick out all the others and add them together, and finally subtract one total from the other. The two-column method also has other advantages which will appear later.

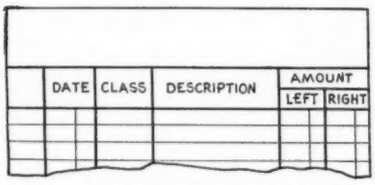


FIG. 1. IMPROVED FORM OF JOURNAL PAGE

It will be noted that the ledger page also is divided into two columns, a left and a right. This is in line with what we have just been considering in the case of the journal. Here again the left side is used for amounts paid out and the right for those received. This makes it a very simple matter to post from the journal to the ledger. All we have to do is to post left-hand items in the journal to the left hand of the ledger account, and, conversely, to post right-hand journal entries to the right side of the ledger account. With this system we do not have to worry about using a red pencil or any other device to distinguish one type of item from another. This is one of the several advantages it possesses.

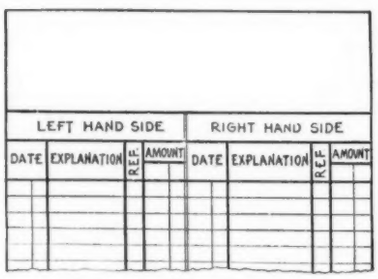


FIG. 2. LEDGER PAGE

We have now discussed in a general way what we must do with the journal and ledger to adapt them to the purpose in hand; namely, the determination of what it is costing to furnish power to the factory. It will now repay us to give a little more attention to the details of our ledger accounts. The ledger is a very important record in any system of accounts and is in reality a complete history of all the transactions that have taken place since the time it was started. To be of any use, it must be a true history and must, moreover, be kept in such shape that it can be read easily.

In the first place we know that the left and right sides are used for amounts spent by us and received by us respectively, from which it follows that the difference between the two sides represents the net expenditures. Let us see how this would work out in an actual case. For this purpose we will consult Fig. 3, which shows the ledger account for Repairs for the month of April, 1921. The postings are self-explanatory. The total

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REPAIRS

LEFT HAND SIDE						RIGHT HAND SIDE					
DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF.	AMOUNT	
1921 Apr.	4	Gaskets	1	6	32	Apr	26	allowance on boiler repair bill	2	12	25
	12	Parts for traps	1	10	75						
	20	Boiler repairs	2	248	59						
	28	Bearing brasses	3	31	17						
		284.58		296	83						

FIG. 3. "REPAIRS" ACCOUNT WITH ENTRIES FOR APRIL COMPLETED

of the items on the left side, $296.83, is shown in small figures underneath the last entry. Since there is only one posting, $12.25, in the right column, it is not necessary to show any total. The difference between the two columns ($296.83 — $12.25 = $284.58) is shown in small figures in the left-hand Explanation column. The fact that it is in the left column indicates that the left side is greater than the right. If the reverse should happen to be true, the difference would be shown in small figures in the right-hand explanation column.

32

REPAIRS

LEFT HAND SIDE						RIGHT HAND SIDE					
DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF.	AMOUNT	
1921 Apr.	4	Gaskets	1	6	32	1921 Apr	26	allowance on boiler repair bill	2	12	25
	12	Parts for traps	1	10	75						
	20	Boiler repairs	2	248	59						
	28	Bearing brasses	3	31	17						
		284.58		296	93						
May	10	Rheostat parts	4	9	02						
	25	Conveyor repairs	6	84	37						
		377.97		390	32						

FIG. 4. "REPAIRS" ACCOUNT WITH ENTRIES FOR APRIL AND MAY COMPLETED

Anyone looking over the ledger could then tell at a glance what facts the ledger account showed.

Having disposed of April, let us suppose ourselves to be at the end of May, and that the same account then presents the appearance indicated in Fig. 4. It is evident that we have added $9.02 + $84.37 = $93.39 to the repair charges, but this amount does not appear

anywhere on the page. What we have done is to add these amounts to the previous total, giving us $390.22 as the expenditures for April and May combined. Subtracting from this the allowance of $12.25 in April gives us the small figures $377.97 as the net charge for repairs for the two months. But, as just stated, the total charge for May alone is not shown anywhere. We can get it readily enough however by subtracting April from the total, thus leaving May. Let us do this; we

50

TOTAL COST

LEFT HAND SIDE						RIGHT HAND SIDE					
DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF.	AMOUNT	
Apr	30	Labor	2	1000	00	Apr	30	Ash removal	26	100	00
	30	Fuel	8	5000	00						
	30	Water	22	100	00						
	30	Lubricants	24	30	00						
	30	Repairs	32	284	58						
	30	Scale removal	38	50	00						
	30	Misell. Supplies	40	20	00						
		284.58		6484	58						

FIG. 5. "TOTAL COST" ACCOUNT WITH ENTRIES FOR APRIL COMPLETED

get $377.97 — $284.58 = $93.39, which we find agrees with the amount already determined. If we wish, a note of this amount can be made in small figures adjacent to the note already made of the total to date. In this way it will be easy at any time to tell both the expense for each individual month and the expense for all the months together.

One of the things that we wish to determine at the end of each month is the total expense incurred. This is done by jotting down the amounts of the various ledger accounts (with the exception of the Investment account) and adding them together. Instead of doing this on a separate piece of paper, we might reserve some pages in the ledger for the purpose and thus make these figures a part of the permanent record. Let us adopt such a scheme and start another account in the ledger, which we may call "Total Cost" or any other name that is appropriate. Let us start it on a page back of all the other accounts and make a memorandum of the page number in the front of the book, where we should also have a memorandum of the page numbers of all the other accounts. After having written in the title at the top of the page, we go over the other accounts and transfer the amounts we find in them to this new account. At the end of April it might look like Fig. 5 and at the end of May like Fig. 6. The entries themselves need no comment since they are self-explanatory. It should, however, be noted that the Investment account does not appear among them. The reason for this has already been explained. Among the items is the one of $284.58 for repairs as taken from the Repair account in Fig. 3. From the illustrations it is evident that the total expense for April was $6,484.58 — $100.00 = $6,384.58. In Fig. 6 all the items for May have been added to those of April. Among them will be found the one for $93.39 for repairs as derived from the Repairs account of Fig. 4. From Fig. 6 we see that the total net expenses for April and May combined amount to $14,002.97 — $220.00 = $13,782.97. In order to determine the amount for May alone, all we need do is to subtract April from the total. Doing this gives us $13,782.97 — $6,384.58 = $7,398.39. If we wish, we can make a memorandum of this amount on the account so as to have it available for ready reference.

Making a survey of what has been accomplished so far, we find that, first, we have a complete chronological record in our journal of every item, large and small; that is, a consecutive history, day after day, of every element of cost in full detail. In our individual ledger accounts we have a summary or gathering together of these details into separate groups or classes of expense, and finally, in our Total Cost account we have brought all the individual class totals together in order to get the grand total. This total should agree with the sum of all the entries in our journal, and a convenient way of checking the accuracy of our work is afforded by this fact. All we have to do is to add the left and right columns in the journal and subtract the one total from the other. The result should be the same as the total for the month shown by the Total Cost account. If the two do not agree, a mistake has been made somewhere and we must hunt for it until we find it and then correct it. There is one thing that will always be sure to make an apparent disagreement, and that is if there are any entries against Investment in the journal.

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TOTAL COST

LEFT HAND SIDE						RIGHT HAND SIDE					
DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF.	AMOUNT	
Apr	30	Labor	2	1000	00	Apr	30	Ash removal	26	100	00
	30	Fuel	8	5000	00						
	30	Water	22	100	00						
	30	Lubricants	24	30	00						
	30	Repairs	32	284	58						
	30	Scale removal	38	50	00						
	30	Misell. Supplies	40	20	00						
May	31	Labor 334.58	2	1200	00	May	31	Ash removal	26	120	00
	31	Fuel	9	6000	00						
	31	Water	22	150	00						
	31	Lubricants	24	40	00						
	31	Repairs	32	93	39						
	31	Scale removal	38	20	00						
	31	Misell Supplies	40	15	00						
		13782.97		14002	97						

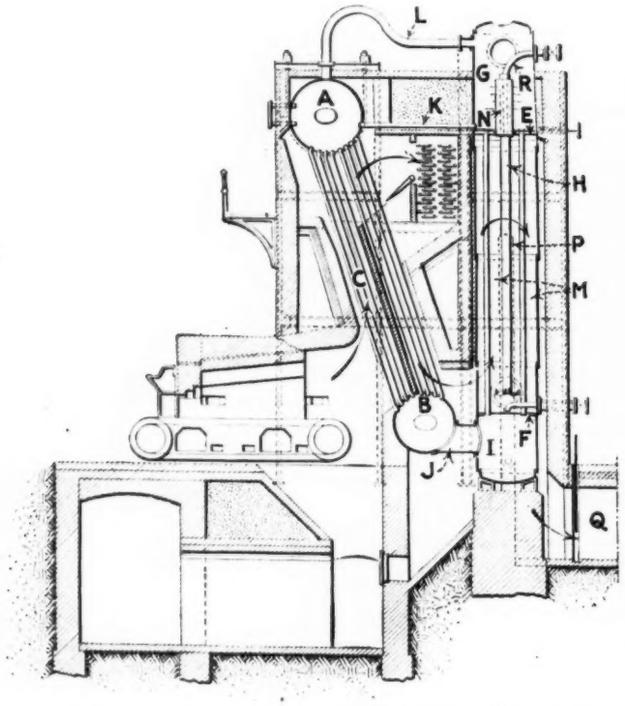
FIG. 6. "TOTAL COST" ACCOUNT WITH ENTRIES FOR APRIL AND MAY COMPLETED

It is, therefore, quite evident that before trying to make a comparison we should run over our journal entries and make a note of any investment items. These may also be taken directly from the ledger investment record. These we must then deduct from the total of the journal entries before we can expect to be in agreement with the Total Cost account.

Brueggerman Water-Tube Boiler

The feature of the Brueggerman water-tube boiler is a water-storage reservoir that is connected with the drums of the generating part of the boiler. The upper part of the reservoir is utilized as a steam dome. The water of circulation passes through the main chamber of the reservoir, and the gases of combustion pass around it.

The generating part of the boiler consists of the upper and lower drums *A* and *B*, which are connected by a bank of inclined tubes *C*. Water is supplied to the drum *B* from the vertical cylindrical reservoir, which is divided by the tube plates *E* and *F* into three compartments, the upper one, *G* serving as a steam dome, the center portion as a water reservoir, and the lower



SECTIONAL VIEW OF THE BRUEGGERMAN BOILER

chamber *I* connecting through the nozzle *J* with the lower drum *B*. The drum *A* is connected to *G* by the pipes *K* which are arranged below the water line. The steam space of the drum *A* is connected by the pipes *L* with the steam space of the chamber *G*. Tubes *M* extend from the upper plate *E* through to the corresponding lower plate, and serve to carry the water of circulation.

The feed water enters through the pipe *R* and discharges from the tube *H* just above the plate *F*. It then rises and passes to the pipe *N* overflowing to the horizontal plates that are arranged around the pipe *N* in step fashion. As the hot water rises through the pipe *N* it overflows on the plates, which breaks up the hot water and frees the air.

Circulation of the water is from the drum *A* through the pipes *K* to the lower part of the steam drum *G* and downward through the tubes *M* through the nozzle *J* and tubes *C* to the drum *A*. The hot water in passing downward through the tubes *M* heats the water in the storage reservoir and this water will be heated also by the flue gases which pass around the outside of the reservoir.

The furnace gases follow the course shown by the arrows. From the back of the furnace the hot gases pass upward in the flue in which the reservoir is located, over the vertical baffle *P*, shown by dotted lines, and then down and out through the discharge flue *Q* to the chimney.

The lower part of the chamber *I* is fitted with a blow-off. The water enters the coldest part of the boiler, and, rising in the reservoir, is heated, serving to separate and deposit the scale-making materials, which collect on the lower plate *F* and can be blown off when desired. This boiler is patented by Albert L. Brueggerman, Newark, N. J.

Boiler-Room Experiences

BY CHRIS. MATTERN

When boiler tubes leak at the rear end head, the trouble is generally due to the manner in which the boiler is handled. Considerable trouble was had at a hand-fired plant with one half of the rear tube head. A new fireman had been engaged and instructed how to clean the fires. After having the tubes rolled several times, it was decided that there must be something wrong with the way in which the boiler was being handled. The fireman was watched while cleaning fires, and it was found that he burned down one side of the fire and that when the fuel on that side was nearly burned out, he pulled out the clinkers and ash. Then, instead of shifting over the clean fire from the uncleaned side, he closed the fire door, leaving the grates bare and went about doing something else, while the cold air rushed through the bare grates and through the boiler tubes on one side. After instructing him for the second time how the cleaning job should be done, there was no further trouble with leaking tubes.

At the same plant it was necessary to renew the front sheet of one of the boilers. The boilermakers laid out the holes in the new sheet, but when it was put in place ready to rivet, it was found that the holes were from $\frac{1}{4}$ to $\frac{3}{8}$ in. out of place. This was pointed out to one of the officials, also the possible consequences that might result, but after considerable discussion the men were allowed to go ahead with the work. It was but a short time before the work had to be done over again, on account of severe buckling and leaking of seams.

On water-tube boilers, particularly the horizontal type, it will often be found that the first row of tubes develop a number of small bags. As many as ten have been counted on one tube in some extreme cases. These can be heated with a light charcoal fire and driven back, thus saving the tube and avoiding a long layup of the boiler.

One of the boilers developed a crack in the bottom of the mud drum. The regular procedure would have been to remove it and wait until a new mud drum could be obtained. It was decided to try the acetylene welding process on the job and save time, trouble and expense. This was when welding was in its experimental stage. The welder cut a V-notch in the header along the crack and then welded it with new metal. It never leaked or gave any further trouble. Two men did the job in less than one day.

The steam rate of a turbine is improved 1 per cent for each 6 to 10 deg. of superheat.

EDITORIALS

Selection of Brushes

SELECTION of brushes for electrical machinery is one of the problems that is frequently up for solution by the operating engineer. At one time little attention was given by either the machinery or brush manufacturers as to the grade of carbon brushes used in any application, the general attitude being that any carbon brush should give satisfaction under every condition. As might be expected, this policy was not productive of satisfactory operation. Latter years have seen a complete reversal of the early idea and there has been a vast amount of investigation work done by the manufacturers to determine the proper characteristics of brushes for different applications; a wide variety of grades has been developed to make a selection from, and this has contributed largely to improved operating characteristics of electrical machinery.

This specialization in brush development led to an idea that the proper application was a job for an expert, and the operating engineer was frequently told that he did not possess the necessary information on which to base the selection to obtain satisfactory operation, and that, therefore, the problem must be referred to the brush manufacturer's engineers. This doctrine might have been an efficient means of holding business after once obtained, but employing an expert for what appears to be an ordinary detail in plant operation lacks an appeal to the average operating engineer. In general, the calling of an expert is something that would be resorted to only as a last recourse. Instead of calling for the expert the selection was made more by guess than any intelligent analysis of the requirements. What has an appeal is giving the necessary information on which to base the selection, or a means whereby the operator may give the manufacturers the necessary information on which to analyze the requirements and make recommendations, as progressive manufacturers have been doing during the last few years. The statement in a bulletin that such a grade is suited for a certain class of service will be more likely to receive attention than a recommendation that an expert is required to analyze the requirements. No matter how carefully the manufacturers may detail the information regarding brush application, it does not relieve the operator from familiarizing himself with certain fundamental principles that need to be considered to select the suitable grade for all normal applications. An article in this issue, "Selection of Brushes for Power-Plant Equipment," by Warren C. Kalb, deals with the various types of brushes and their applications. A careful consideration of the factors outlined by Mr. Kalb should enable the operator to select grades adapted to any standard equipment operating under normal conditions.

In the selection of brushes two general conditions are met; namely, the renewal on machines that are operating satisfactorily and those applications where commutation troubles are experienced. In the former it is only a matter of obtaining a new set of the same grade as the old ones and properly installing them. With the latter application many factors are involved, including not only an analysis of the machine's condition but also consideration of the load; and, in the case of a generator, the prime mover must also be considered. Any of these may produce conditions that are detrimental to commutation and should be corrected before any attempt is made at selecting brushes. Although brushes of the proper type may have an important bearing upon machine operation, they cannot be expected to compensate for serious defects in the machine or load application.

A Healthy Industry

AT A TIME when one hears comments on business depression at every turn it is indeed refreshing and reassuring to sit through sessions such as those of the recent convention of Edison Illuminating Companies at Spring Lake, N. J., and note the evidences of stability in the central station industry. While the load in certain sections has fallen off to some extent, in no case alarmingly, others have shown a decided gain and new plants are being constructed to meet this demand; in fact, one large metropolitan company is said to be anticipating an increase of nearly twenty per cent during 1922. Statistics for the first half of 1921 covering approximately seventy-five per cent of central-station capacity show an average loss of about five per cent in load over 1920 but an increase in revenue, due probably to the more satisfactory fuel situation.

And why this healthy condition in contrast to that of business in general? There are several contributing factors, but primarily the industry has been built up on the idea of service, the systems have been carefully planned and extended, and loads selected to the end that a high degree of diversity has been attained. Moreover, the greater part of the capital represents investment in permanent equipment and therefore does not require liquidating during a period of readjustment, as compared with those industries whose capital is tied up in materials subject to market deflation.

During the war, equipment was hard to obtain and it was imperative that power demands be met. The obvious thing was to run with a smaller margin of reserve. This taught that unnecessarily large reserves had been carried. Profiting by this experience many of the companies have since reduced their reserves with a corresponding reduction in fixed charges, which has to an appreciable extent tended to offset increased operating expenses.

To the foregoing add constant effort to increase efficiency in the generation and application of electricity and we have the answer to the present condition of the industry.

Indications are that power demands during the next ten years will increase at a still greater rate than during the last decade, which at the time far exceeded all expectations. Many of the companies are preparing to meet the demand that will come with revival of busi-

ness. The present is a buyers' market with regard to equipment and it is therefore opportune to start new work. Although money is still high there is a growing tendency to circumvent this difficulty by financing directly through a large number of small investors and consumers.

A Leading Factor in Oil-Engine Development

ENGINEERS are generally convinced of the superior thermal efficiency of the internal-combustion engine. Equally convincing is its record for reliability and continuity of operation. Unfortunately, these are but two of the many things that must be considered in choosing a new prime mover. The other factors of vital concern are the probable fuel supply, the life of the machinery and its first cost. The problem of the fuel supply can be eliminated, for there is every reason to presume that a supply of liquid fuel will be available for centuries to come. The question of wear and tear has already found its answer in the record of hundreds of oil engines that have been in operation for ten to fifteen years.

The high first cost, on the other hand, is often the factor which dictates a choice of some other form of power. The manufacturers of oil engines of all types should not ignore the condition, but should use every effort toward a lowering of manufacturing costs. Undoubtedly, a reduction of finish on non-vital parts would bring a corresponding reduction in cost. Costly accessories or attachments which, although giving a slight increase in efficiency, more than offset this gain by their cost, should be eliminated.

Reduction in the number of sizes of engines built would be of advantage to the purchaser, since methods of economical production could be installed to replace the present method of building single engines.

A study of the thermodynamics involved leads one to conclude that the gas turbine will not supplant the more efficient reciprocating oil engine unless its manufacturing costs be low. A clear field is before the oil-engine builder if he will turn his efforts toward a reduction in costs, which in turn will undoubtedly multiply the demand for this type of power.

Be Your Own Efficiency Engineer

POWER-PLANT engineers hear what the so-called efficiency engineer has accomplished in the factory and often either ridicule his achievements or look upon him as a sort of superman. If they were in a position to look a little deeper they would soon discover that there are good reasons for his success and that they can emulate him. Why does the efficiency engineer succeed in increasing plant efficiency by reducing lost motion, eliminating needless re-handling and so on? He succeeds by taking up his task with the express intention of finding fault. His one purpose is to improve existing conditions. This means that he must examine each detail of the problem, study its relation to the whole and improve it individually as well as co-ordinating it with the whole.

In the same way, every stationary engineer might be his own efficiency engineer. There is plenty of scope for such work in most power plants, and who is better fitted for the work than the man who is conversant with all the details involved and the daily routine required?

In many cases the trouble is, of course, that a man gets in a rut. His work being largely routine, routine becomes a habit and the man becomes a slave to it. In consequence conditions that would immediately attract his attention in some other power plant go on unnoticed in his own. This is probably the reason why it is so easy to find fault with the other fellow and overlook identical faults in ourselves. It also explains, no doubt, why so many engineers newly taking charge of a plant are able to eliminate shortcomings and bring about improvements. In taking up his new duties, the engineer is brought face to face with a new set of conditions that demand study and action and so take him out of his accustomed routine. Observation, study and action are the key to getting things done in the power plant. They mean keeping one's eyes open, reasoning things out and acting upon the findings.

It is human nature to strive for the things most difficult to attain and overlook the little things closer to hand. It is the little things that count in the power plant, the little things that close observation will detect. A heat balance is a good thing and is vital in its place, but the many loose ends such as leaks, escaping steam, delapidated pipe coverings, cracked furnace walls and so on must be stopped first before a heat balance means much toward higher efficiency.

No doubt, as predicted at the recent convention of the American Chemical Society, long before our coal and oil resources are exhausted new sources of energy will be utilized that will prove ample for our needs. Considerable attention has been given to harnessing the sun's radiant heat, but so far not much in a practical way has been accomplished; in fact, so little has been done that there are grave doubts as to what the future may hold, although some of the prophecies are very optimistic. If no other means is provided, the use of waste lands to grow plants from which to produce alcohol and oil hold more than a prophecy. However, until there is a more promising possibility of obtaining cheaper sources of fuel and power than we have at present, it will be to our best interests to utilize what we have to the greatest advantage, not for today alone, but also for the future.

Improvement in boiler-operating methods has made it possible for an attendant to take care of boiler capacity for producing twenty times as much steam as by the old methods. As a further improvement combined boiler and furnace efficiency has been increased from approximately fifty per cent to eighty per cent, and in some few cases even higher combined efficiencies have been obtained, at an operating cost of approximately fifty per cent of what it was formerly. This is what we can do. How long will it be before it will become the rule and not the exception?

Those in charge of power plants who are about to contract for their season's coal would do well to emulate the action of one large power company which has inserted a clause in its coal contract providing that the coal shall come from certain mines and if the operator should supply coal from these mines to any party at a price less than that stipulated in the contract the power company shall benefit correspondingly. This safeguards against a falling market when buying early.

CORRESPONDENCE

By-Product Heat

Contained in F. R. Low's editorial "Not To Be Leaned Upon" in the August 23 issue of *Power* is the crux of the whole coal situation, only it is not brought out so as to be visible. It is contained in the one word "Heat."

We are people of fads. We take up a subject and go the limit. Centralization has been our hobby for some years. We are scheming in every way to carry it to the *nth* power, and one of these schemes is "Mine-Mouth Power Plants," because the railroad situation is approaching its limits to feed the big condensing central stations and, at the same time, supply the people with "Heat."

Notwithstanding Senator Reed's insistence to the contrary, coal is exhaustible and therefore "Heat," as we now know it, is exhaustible. It stands to reason, therefore, that those important parts of the world requiring "Heat" have only a limited lease on the territory they occupy. Coal, oil and wood are the only heat-producing articles available to supply the demand for heat in quantities sufficient to meet our needs. Wood is exhausted for this purpose, as is also oil for general heating applications, and coal will be. Therefore, we must make "Coal" and "Heat" synonymous and the foregoing on "Heat" may be read by substituting the word "Coal," its synonym.

Now, these central stations are of necessity throwing away heat (coal). I have talked about this for some years, as evidenced by previous articles sent to *Power*, but life is short. This generation wants all it can get while the getting is good, and the future can take care of itself.

But, is this good engineering? Are engineers still so subservient to the pocket-book that they continue to construct, for financial considerations, engines of ultimate danger to the race? For a thousand years are easily spanned by twenty succeeding lives as only forty succeeding lives could transmit from father to son the actual happenings since the time of Christ.

Now, we have been reading about the "Super-Power Surveys" and the linking of all central stations in a given area together to balance load conditions and smooth out irregularities of operation. *Mechanical Engineering* has an excellent article dealing with the importance of small-stream water-power plants being established and tied in on this same super-power system. It is pointing the way or indicates the clutching at the proverbial straw. Mr. Low touches on this phase in a different light when he refers to the Saar Valley, Silesia and Mexico. It may be a long way off, but this is the distant thunder of the approaching storm.

But in all these articles you do not see any indication of linking up the heat-producing power by-product isolated plant. Often, a manufacturing plant requires considerable heat in proportion to the power necessary to run its machinery, and the reverse of this condition is also often the case. The plant requiring considerable heat could economically generate electric energy up to the point of burning sufficient coal to do its own heating with exhaust steam; and, by linking up with the electric transmission lines, could pass its surplus energy to that plant which needed more power in proportion to its heating requirements. Then, a rather small central station—say sufficient in size to supply the summer load when heat is not required—would balance the load, and if the small-stream summer-operated hydraulic plants are also hooked up the heat (coal) loss would be still further reduced.

On the cover of the issue of *Power* containing Mr. Low's editorial was an illustration of the largest cooling tower in the world. Look at this and visualize the coal (heat) disposed of. In fact, it says it "dissipates" 6,500,000,000 B.t.u. per day. Dissipates is a proper and suggestive word and we tried to check the dissipated individual. If the station in question converted seventy per cent of the energy in the coal into heat going to the cooling tower, what waste is apparent? This is simply used as an illustration. We know the value of cooling towers and their application but it is simply to show the enormous waste when improperly applied.

Another point in this same central station scheme is the application of laws preventing, say, a forge shop from selling its exhaust steam to an adjacent machine shop for heating. It becomes a public utility while, as a matter of fact, it is a public benefactor, for such a sale saves coal. Rather than tax the forge plant it should be encouraged to make an investment to carry the steam to the other fellow who needs the heat and get the revenue thereby rather than tax him as a utility and compel him to waste the steam or heat (coal). The day is rapidly approaching when the extravagant waste of heat will be frowned upon and the same arguments used here for tying in of electric service will be used to tie in "heat" service as well.

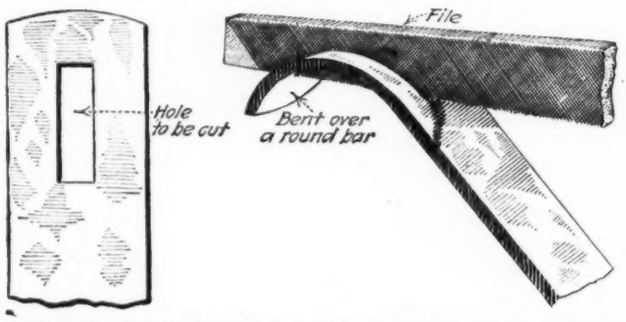
If we could grasp the whole matter as of national importance and survey it from a broad standpoint, it would go a long way toward prolonging our natural heat-producing resources, besides saving enormous amounts of money.

Each little B.t.u. rrom steam coal is worth today .00016 cents.

S. R. SAGUE,
Member A. S. M. E.

Putting a Rectangular Hole in Spring Steel

Some time ago I had to repair some broken mainsprings on recording instruments, as on account of war-times, repair parts were not to be had. While it was some job to get the springs out of their cases, there was a worse problem. The nearest machine shop was twenty miles away and the job was to make square-end



USING FLAT FILE FOR MAKING SLOT IN STEEL SPRING

holes for the ratchet spindle and get the instruments back into service. There were no drills, otherwise the holes could have been drilled and then filed to size; also there were no punches. Using a spare piece of spring, I tried to punch the holes, after first drawing the temper, but the spring material was harder than the center punch. Later a hole was made, but in testing out it tore at the corners.

Finally, I carefully drew the temper on one of the springs and bent the spring-end around a small bar. After marking out the size hole wanted, I took a flat file and with the narrow edge filed the hole through on the bent-over portion. It was also found that it was possible to cut fillets of about ¼ in. radius in the corners to prevent tearing out. The spring was tempered in cylinder oil and assembled in the instrument. These springs have now been working for three years.

Irvington, N. J. JOHN S. CARPENTER.

A 200,000-Kilowatt Steam Station for Glasgow

The brief description of the new Dalmarnock station of the Glasgow Corporation, given on page 392 of the Sept. 6 issue, should prove interesting to American engineers. As a possible indication of the trend of British power-plant practice this plant is worthy of considerable study.

The first impression is one of lack of unity or consistency in the design. Upon more careful consideration, however, all branches of the plant show an unexpected consistency in inconsistency—in other words, variety seems to be the aim in the choice of plant equipment and the arrangement thereof, to such an extent as to convey the distinct impression of an *experimental* plant. The five turbines already installed are of three different types—two are of the straight series-flow impulse type, a third has the last stages arranged for double-parallel flow, and the last two are of the new Baumann multiple-exhaust type.

The heat-balance control system is all but inextricable. As described in the article referred to, the feed water may apparently be heated by any combination of five different methods: In the closed or in the open heaters of two main units by means of the exhaust from the house turbines; or in the closed heaters of four of the main units, with low-pressure steam bled from the turbines; or in the open heater of the fifth unit, by means of the exhaust from the steam-ejector air pumps; finally, by turning the exhaust of the steam-driven feed pumps into the hotwell. There is no excuse for such complexity unless for the purpose of determining experimentally the relative value of the different systems.

The drive of the station auxiliaries exhibits the same unexpected variety. Normally, the auxiliaries for two of the main units drive from a house turbine, and the remaining three from auxiliary windings on the main transformers—a very economical method. In an emergency all may apparently be driven from duplicate three-phase station transformers or from the two house turbines. In the high-tension switching and wiring commented upon in the editorial entitled "Foolproof High-Tension Switching," in the Sept. 6 issue, we find perfect unity of design, but along exceptionally radical lines, all current-carrying parts including the buses being completely enclosed in metal casings filled with insulating compound. Whereas our leading power engineers are advocating the complete separation of phases inside the station, this plant puts them all together in one casing. This seems like putting all its eggs in one basket with a vengeance.

There are a number of individual points of interest. For instance, steam is bled from the turbines for feed-water heating, not at atmospheric pressure as in all our latest plants, but at a stage corresponding to a 19-in. vacuum. This arrangement necessitates the adoption of closed instead of open heaters, the heater being in fact an auxiliary condenser working in parallel with the main condenser but at a lower vacuum, in which the bled steam is condensed by the condensate from the main unit. The advantage of this method is obvious, the lower the pressure at which steam is bled the more work it will have done before it gives up its heat. It does not seem particularly wise at first sight, to have chosen a closed heater of the surface-condenser type for this service, since the bled steam, after being condensed, will be mixed with its own condensing water—the main condensate—in the hotwell. A jet condenser would be less costly to install and do the mixing directly. It would, however, require a condensate pump of sufficient capacity to handle the condensing water—that is, the main condensate—plus the condensed steam bled from the turbine. Now the main condensate has already been pumped twice before it reaches the heater, and the use of a surface-condenser type of heater obviates a third pumping, for the extraction pump will only have to handle the steam actually condensed. Furthermore, all the disadvantages inherent to the surface condenser except its high first cost—mainly the difficulty of avoiding leaks and the necessity for cleaning and repairing tubes—lose weight from the fact that the condensing water is distilled, that the condensate and condensing water will eventually be mixed, and a perfect vacuum is therefore of relatively small importance.

The general lines of the design do not diverge much from those of our latest plants, except in the capacity of the generating units. No American plant of the same size would have been equipped with such a large number of small units. The low-tension bus connecting the different generators has been omitted, as in many of our plants, each generator being permanently con-

nected to a bank of step-up transformers feeding into a pair of high-tension buses. This construction seems likely to become standard practice both in America and on the Continent. The omission of all provision for receiving coal by water, although the plant is located directly on the banks of the Clyde, is rather surprising until we recall that Glasgow is practically in the midst of the coal fields and that the coal can probably be hauled to the plant by rail more cheaply than by water.

On the whole it cannot be said that the Dalmarnock Station is a radical departure from standard British or American practice, mainly because there is really no standard practice in either country at this time. Power-plant design is in a period of unusual growth, and nearly every new plant has something novel in its design. For this reason, though many may question the economic soundness of the design of the Dalmarnock plant, valuable lessons may be learned in the future from careful study of the results obtained in the operation of this station, particularly in the matter of heat-balance control and auxiliary drive. The very complexity of the design makes for exceptional flexibility in operation and affords a rare opportunity to test out the different combinations under actual operating conditions. In the hands of competent engineers, the Dalmarnock plant should therefore prove a boon to the industry of power generation. A. LANDRY.

New York City.

How To Detect Scale in Boiler Feed Pipes

Frequently, a correspondent will tell of an interruption of service or a narrowly averted accident, due to the accumulation of scale within a boiler-feed line. It is surprising that so many plants are operating without a means of detecting this condition as it develops.

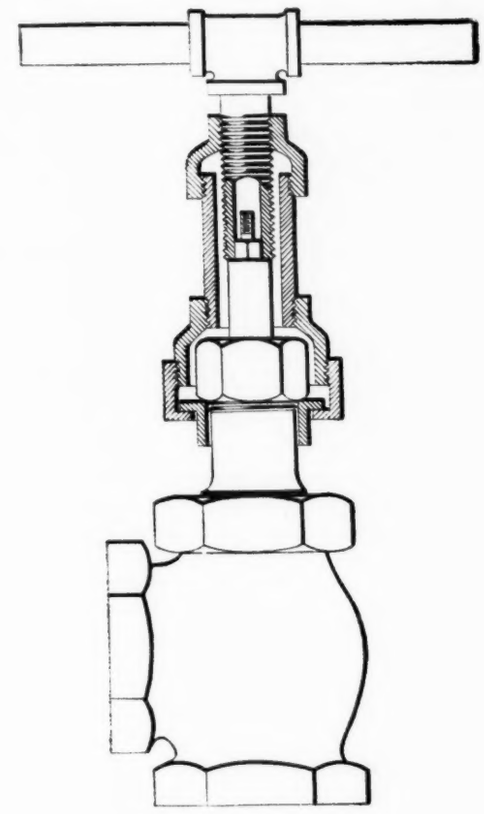
By drilling and tapping the outlet connection of the boiler-feed pump on the pump side of the first stop valve, and connecting up an ordinary pressure gage, a constant indication of the condition of the feed line is available. With the pump operating at normal speed and making allowance for friction losses, etc., any considerable increase in feed-line pressure over the boiler pressure is a positive indication of trouble in the feed line and should be investigated. The gage is also useful for indicating the condition of the pump valves, for by opening wide the gage cock, the pulsation of each pump stroke may be noted; a leaky valve will cause the pulsation to be less on the stroke effected by it.

In only one case to my knowledge has a gage failed to indicate feed-line trouble, the circumstance of which will speak for itself. A green fireman accidentally shut all the boiler-feed valves and then discovered that the feed pump had stopped and that the gage stood at zero. Instead of calling the engineer, he proceeded to get excited and to start up the spare feed pump. It also refused to go, and it is doubtful what his next move would have been had not the engineer happened along and noticed water leaking from under the grease-extractor cover. Taking in the situation, he opened one of the feed valves and both pumps went to work in a hurry. An examination of the gage showed that the needle had been forced around until it hooked over the pin at zero and could not return. A new fireman remedied the situation. A. C. MCHUGH.

Norwalk, Cal.

Emergency Repair to Valve Stem

The accompanying sketch shows a repair made to a 1½-in. valve used aboard a steamboat and it was indispensable. The threads on the valve stem and likewise in the bonnet were so worn that they stripped, permitting the pressure under the valve disk to force the valve open. By the aid of the 1½-in. union, a short 1½-in. nipple and a 1½ x ½-in. reducing coupling, a substitute bonnet was made, as shown. Then with a ½-in. piece of pipe threaded for a stem to enter through the reducing coupling, a ½-in. tee and two short ½-in. nipples for a handle, the job was complete, and worked as satisfactorily as a sound valve. When we reached port, it was replaced by a new valve.



DETAILS OF THE REPAIR

Detroit, Mich. CHARLES MURPHY.

Emptying Barrels with Compressed Air

An article by D. A. McNulty in the Aug. 16 issue recalls two incidents in my early career. When in high school and studying physics, the following experiment was supposed to illustrate or demonstrate something: An oil barrel was filled with water, and a vertical pipe about 20 ft. long was screwed into the side. From a second-story window a small quantity of water was poured into the pipe and the head came out of the barrel.

Some years later a factory superintendent wished to raise oil from a barrel to a floor about ten feet above by compressed air and promptly forced out the head of the barrel. Thinking that the air had been turned on too suddenly, he made a second attempt on another barrel. Still unsatisfied, he sacrificed a third barrel and then gave up the attempt.

The area of a barrel head is not very far from 300 sq.in., therefore 5 lb. per sq.in. gives a total pressure of 1,500 lb. on the head, which probably would be sufficient to force it out. In the apparatus described in the article referred to, the air inlet is pretty well restricted and therefore the pressure in the barrel may be kept down to a safe value when a light oil is being discharged at a low head. However, the air should be used with considerable caution as any restriction of the discharge, due to greater elevation, a heavy oil or an obstruction of any sort in the oil pipe, would quickly produce a pressure sufficient to burst the barrel.

Washington, D. C. H. M. PHILLIPS.

Opening and Closing the Blowoff

Two cocks or valves are put on a boiler blowoff, or one cock and one valve, to prevent leakage. In years past, and even today in some plants, the boilers are operated with but one blowoff. The plug cock was the best-known fitting for this use, as it was a straight-way that would not collect scale, but gate and angle valves, made especially for this purpose, came into use and the stop cock is still used in connection with these special valves.

The installation and conditions in the plant govern the procedure of manipulating blowoff valves, and safety first is a good motto in all cases. No one can tell how rotten a blowoff pipe may be that has been in service any length of time, or how much it may have been sprung to get the pipe connected. In one plant a steamfitter put in a piece of common pipe for a blowoff, with extra-heavy fittings, without the knowledge of the engineer. It is difficult to detect common pipe after it is in place from an extra-heavy one. Common pipe will wear thin and may fail at any time after a short period of service.

Placing the stop cock next to the boiler is a good practice if the boiler is in a battery, because a stop cock will wear out and leak. With a flange between it and the valve the stop cock can be replaced with a new one when the boiler is shut down, and the valve will hold back any leakage from the other boilers.

Stop cocks rapidly wear out on the packing and on the closing edge of the plug if opened last. To blow down, no matter on which side of the valve the stop cock is placed, it should be opened first and then the valve. This will insure longer service for the stop cock, and the valve which is always opened slowly permits the pressure to come on the pipe and fittings gradually, thus avoiding sudden shocks from water hammer. When through blowing down, close the valve first so as not to stop the high velocity of the flow of water under pressure too suddenly, or the pipe or fittings between the valve and boiler may fail. Never shut a valve too tight, especially when cold, as expansion from heat will cause it to stick.

If the valve were opened first and then the cock, it would be difficult to open it slowly because the plug has expanded and stuck. The consequence is that it opens suddenly when extra strength is put on the wrench. If the valve is placed next to the boiler, especially if of the gate type, the bottom of the wedge on the opening and closing edge will tend to cut.

I have had several plants with the valve placed next to the boiler and find the cocks and valves, when so arranged, wear about the same. If scale of coarse size lodges in the pocket of a gate valve, closing the valve will break it and then opening it again will allow the scale to blow through.

The angle blowoff valve of the piston type is desirable, as the seat and disc do not easily cut away; and the plug cock is frequently placed between the valve and the boiler. Unless the cock leaks, there is always some wear on the closing edge of the plug, because there is no pressure between the plug cock and the valve. The boiler pressure holds the plug against the opposite side of the case and, when opened with care, puts the pressure gradually on the angle valve; then the plug cock can be opened wide and the valve gradually opens.

If the blowoff of a boiler becomes plugged, cut the boiler out of service and reduce the pressure twenty pounds or more below that on the others. Then open the blowoff valves and blow back into the boiler.

I always install the gate valve next to the boiler and the cock outside when a gate valve is used. When an angle valve is used, I put the plug cock next to the boiler, which takes the strain off the bonnet of the angle valve, which has the tension of the screw of the stem plus the boiler pressure to sustain, while the gate valve is wedged in between the two sides. Never open the valve first; open it last and close it first. When it wears, new seat rings and disc can be put in. R. A. CULTRA.

Cambridge, Mass

Valves in Water-Column Connections

In a recent issue of *Power* was an article by W. H. Wakeman, in which he claims that valves on the connections between water column and boiler are a necessity. I will agree that they are at least a convenience, if not a necessity. As proof of this one or two incidents are cited in connection with this matter.

In a certain power plant there were six water-tube boilers. One morning in midwinter, about 6 o'clock, the top connection between the gage glass and the water column on one of the boilers broke off close to the water column, apparently from no cause other than the steam pressure. Upon arriving at the plant, I found the boiler room so full of steam that it was impossible to see a water column or a steam gage, and the noise of the steam issuing from this small opening, at 200-lb. pressure, was deafening. It is easy to understand the difficulty of getting rid of the steam in a boiler of large size with a heavy fire and underfeed stokers, and no chance to smother the fire with wet coal.

To add to the trouble, the day load was just coming on, and as it required every boiler that was available at that time to carry the load, some of it had to be dropped until repairs were made and the boiler put back on the line again. It required but a short time to remove the broken connection from the water column and put in another, but had there been valves between the water column and the boiler, the loss from power would have been eliminated, to say nothing about the other difficulties met with. Apparently the broken connection was due to crystallization, as the part that was removed from the column would break like glass.

Another case can be cited where the valves on the gage glass connections leaked so badly that when the glass broke it could not be renewed until the end of the week when the boiler was taken off the line.

At another time the water column split for nearly its whole length. Of course the boiler would have to be taken off the line anyway, but the steam and water blowing out made a disagreeable mess, which could have been avoided if there had been valves on the connections.

Lowell, Mass. E. C. WELLS.

Welding a Hydro-Electric Generator Shaft

We have recently noticed an article appearing on page 61 of the July 12 issue of *Power*, describing a method of repair to a broken shaft on a hydro-electric generator in the plant of the Bangor Railway and Electric Co., Bangor, Me. In this article the following statement is made: "The trouble was probably the result of faulty design of the bearing," etc. Again at the end of the article: "The manner of making the repair made it possible to redesign the apparently improperly designed thrust bearing so as to make it stronger."

We, of course, take issue with the statement that the design was incorrect. There are many of these generators with the same design running and in service for as high as ten years without failure or complaint. Such shafts are rarely broken, and every case of breakage has been found to be due to either one of two things—improper workmanship, which is not improper design, or the failure of the babbitted guide bearing below the rotor, which will allow the shaft to swing between ¼ and ½ in. play in a bearing that is supposed to fit closely. When the babbitt melts out of the babbitted bearing, from lack of lubrication or failure of oil supply, it immediately establishes a degree of play of the shaft in the bearing, which is not permissible for safe operation.

In the particular case cited, we understand that the babbitted guide bearing, which fits the shaft just above the forged-flanged coupling, did give out at some time prior to this break, and we feel there is no doubt that the failure of lubrication that caused the play in the babbitted bearing was primarily the cause of the broken shaft.

Any type of vertical generator in which a freedom of play occurred in the lower guide bearing, such as was experienced in this case, would suffer a broken shaft in a short time. We have know this to occur in a number of different makes of vertical generators.

Incidentally, to prevent the probability of breakage from a worn-out babbitted bearing, we have dispensed with the use of babbitted bearings and provide our generator with roller guide bearings throughout, as well as roller thrust bearings of the same general design as used in the generator referred to.

TRUMAN HIBBARD, Secretary,
Elec Machinery Mfg. Co.,
Minneapolis, Minn.

Lubrication of Bearings and the Bastard File Treatment

Referring to R. H. Larkin's letter on page 461 of the Sept. 20 issue, concerning lubrication and the molecular attraction of contact, with particular regard to the practice of applying a coarse file to journal surfaces for the purpose of assisting the formation of the oil film, Mr. Larkin's recommendation that the file treatment be applied to the babbitt metal of the bearing rather than to the shaft, whenever possible, raises the interesting point as to *when* this is possible. In most sight- or gravity-lubricated bearings, each of the two bearing surfaces has a distinct mission to perform. The duty of one of them is to allow the oil to flow over it with the least possible resistance and to distribute it evenly over the journal surface, while the latter is expected to draw the oil around between the two surfaces, to wrap itself in a film of oil. To accomplish this it relies partly on the adhesion of the oil to the metal, but mainly on the mechanical effect of minute irregularities or projections on the surface, that tend both to push and to drag the oil along with them. It is to increase this last effect that a file may be used to roughen the metallic surface.

Now it is clear that if a surface must wrap itself in a film of oil, it should move continuously in one direction with respect to the point at which the oil is fed into the bearing. Thus, in most stationary bearings, the shaft revolves continuously in the same direction and should draw the oil around itself. If it is too smooth, it may be given the "bastard-file treatment," but on no account should the file be applied to the babbitt surface, for any roughness of the latter will tend to shave down and destroy the oil film.

A crankpin bearing is a special proposition, however, in that both bearing surfaces are in motion. Which of the two will be entrusted with the formation of the oil film will depend entirely on the system of lubrication. For example, if this is of the centrifugal-oiler type, where the oil is admitted through the center of the crankpin and fed to the bearing through a passage inside the pin, the surface of the latter will evidently be stationary with respect to the point of delivery of the oil, and it will be up to the babbitted surface of the brasses to form the oil film. In this case the brasses may be roughened up to assist the formation of the oil film, and the pin should be left as smooth as possible.

On the other hand, if lubrication is accomplished by the so-called wiper-cup process or some sort of splash process by which the oil is fed through a hole in the brasses, the babbitted surface is now stationary with respect to the oil delivery. Hence the formation of the oil film falls to the journal surface, and a file should on no account be used on the babbitt, but only on the pin.

New York City. A. L. DREW.

The Law Should Be Obeyed

A question that I would like to have answered is: Why have an Ohio state boiler law at all when the state itself keeps on breaking it? The law says that "a water-tube boiler fired by hand shall have doors provided with substantial latching devices to prevent them from being blown open by pressure on the furnace side." No latches will be found on the firedoors here, although ordered put on by the inspector several times.

The law also says, "When shutoff valves are placed on the pipes connecting a water column to a boiler, these valves shall be of the straight-way, outside screw-and-yoke type, and shall be locked or sealed open." My No. 1 boiler has a globe valve on the water connection to the water column and one on the steam connection.

I know an engineer who has his fifteenth issue license, who says that an eccentric is shrunk on the shaft and that this plant is running condensing, when it is not. One night he let the main engine bearing run hot and melt out. He said it was caused by the day man taking up the crosshead and crank boxes and not telling him about it. Why not examine such fellows?

When I started firing here, they were running two boilers, and when I came on I banked one and carried the load on the other. This same engineer told me it was an "awful waste of fuel" to carry such a hot fire.

Xenia, Ohio. W. F. POPE.

INQUIRIES OF GENERAL INTEREST

Advantages of Hexagon Over Square Nuts—What is the advantage of hexagon nuts over square nuts for through stays of boilers? H. L.

For the same distance across diagonally opposite corners, the hexagon shape has more stock between the tapped hole and the flat sides of the nut, and when the square shape is made large enough for obtaining the same strength, any inequality of bearing at the corners is farther from the center, bringing a greater bending stress on the threaded part of the bolt. In addition to these advantages the hexagon form of the same strength as a square nut requires less space, presents a better appearance, permits of shorter sweeps of a wrench and, being smaller in diameter, the bearings at the corners offer less resistance to screwing up the nut to obtain a given bolt tension.

Re-turned Crank Pin Out of Round—After having the crank pin of a center crank engine turned up in a lathe, careful calipering shows that the pin is not perfectly round. What would cause this? F. F. R.

Turning done on a lathe is not perfectly round, for neither the tool or the work is absolutely rigid with respect to the lathe centers or with respect to each other. There may be a variation in depth of cut from one side of the crank pin being harder than the opposite side. In turning up a center crank, trouble would be likely to arise from springing of a long turning tool and it may be that the machinist, not being provided with facilities for grinding the pin true, has made it worse out of round by attempting to finish it with a file.

Spontaneous Combustion of Bituminous Coal—Under what conditions is stored bituminous coal likely to become ignited from spontaneous combustion and what means can be taken to extinguish the fire? W. L. E.

When bituminous coal is piled more than 6 to 10 feet deep it is very likely to take fire by spontaneous combustion, unless the body of the coal is kept cool by thorough ventilation. The length of time required for active ignition, after the coal has been placed, varies with different coals. If the coal is piled in very warm weather, or is stored in a warm place, spontaneous combustion is likely to occur all the sooner. Once any considerable part of a pile is ignited, it is difficult to extinguish the fire with water thrown over the top of the pile, as that forms a crust above the burning coal which, unless it is completely flooded under water, or turned over, must be left to slowly burn out. The gases arising from the burning coal in the early stages of ignition give ample warning of the conditions, especially to occupants of the building in which the coal may be stored and, under circumstances where it is possible, the burning and heated parts of the coal should be promptly dug out and cooled or if practicable the whole pile should be flooded.

Effect of Changing Weight of Governor Balls—When an engine is fitted with a flyball governor, how is the speed affected by changing the weight of the governor balls? W. H.

If the flyballs of the governor had no spring resistance or weight to raise but their own weight, and had no friction to overcome, but were employed solely for regulation of speed from position assumed by centrifugal force, it would be immaterial how heavy or light the balls might be, for with the same length of arms to the center of gravity of the balls the same speed would bring balls of any weight to the same position. When the upward motion of the balls is resisted by more than their own weight, the centrifugal force due to a given speed is prevented from carrying the balls to as high a position as they would be carried if unopposed, for the balls cannot rise higher than the speed is sufficient for the centrifugal force to overcome the resistance. As centrifugal force increases with the weight and square of the number of revolutions, increasing the weight of the balls will make the governor more powerful for overcoming the resistance, and a slower speed of rotation will be required for bringing the governor to a position corresponding to a given point of cut-off. The same effect is obtained by decreasing the weight or other resistances that oppose the rising of the governor balls; and, on the other hand, reducing the weight of the governor balls or increasing the resistance, will cause the governor to regulate the engine at a higher speed.

Reversed Phase on Elevator Motor—An electric passenger elevator is driven by a polyphase alternating-current motor. In making repairs to the outside line or service circuit the lineman accidentally reversed connections in one phase. What effect would this condition have upon the operation of the elevator? N. R.

Reversing connection of one phase of either a two-phase or a three-phase motor will cause a reversal of rotation. Therefore if the connection of one phase of a polyphase elevator motor is reversed accidentally, then when the operator throws the starting device to the up motion the motor will revolve in a direction to produce down motion of the car, or vice versa. This is a very dangerous condition, especially with a mechanical control, since if the car was at the bottom landing and the control gear was pulled to the up motion the car would start downward. This would cause the equipment to run on the limits and prevent stopping the machine. Unless there are limit switches, located in the shaft that are operated by the car when it runs by the top or bottom landings that open the main-line switch, thus cutting the power off from the motor, the counter weights will be pulled into the overhead work and serious damage may result.

To prevent the foregoing trouble the National Board of Fire Underwriters require that "Alternating current motors operating freight or passenger elevators or cranes, that are dependent on phase relation for the direction of rotation, must be protected by approved automatic circuit-breakers (or reverse phase relay) operative in the event of any phase reversal that would cause a reverse motor rotation, or in the event of the motor being connected to the line single phase."

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication and for the inquiries to receive attention.—Editor.]

N.A.S.E. Annual Convention at Evansville

Membership Reported Over 19,000—R. W. Parry the New President—Henry Kreisinger Among Speakers—Des Moines Chosen for Next Convention

THE thirty-ninth annual convention of the National Association of Stationary Engineers was held in Evansville, Ind., during the five days of Sept. 12 to 17 inclusive. It was the third time that Evansville had been so honored, and, as in the past, the home local responded well to expectations. Although not so large as in recent years, the convention was a decided success. The technical papers presented were exceptionally good and were much appreciated. The booths in the exhibit numbered 128. As to the entertainment, Evansville lived up to its reputation of the past.

Monday was the day of arrival and registration. In the evening the mechanical exposition was officially opened, with addresses of welcome by Henry Kleymeyer, president of the Evansville Chamber of Commerce, and J. J. Morris, president of the Manufacturers' Association. Responses were made by President Chapman of the Exhibitors and by National President Alfred Johnson. Charles Streithof was the presiding officer. Later in the evening an informal reception and dance was held at headquarters, the Hotel McCurdy.

Tuesday morning was devoted to the opening exercises of the convention. A royal welcome was extended to the engineers by Mayor Bosse, and the preamble of the association was eulogized by James R. Duncan of the Chamber of Commerce. Responses were made by Messrs. Johnson, Parry and Callahan, all association officials.

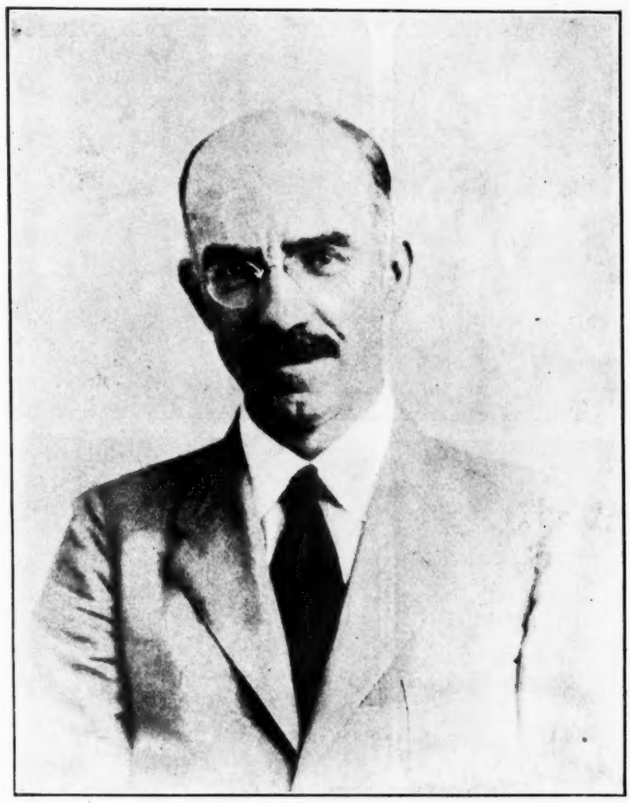
With the preliminaries over, President Johnson took the chair, appointed the usual committees and in his address gave an account of his stewardship during the past year. In this period, he said, twelve new associations had been formed and 4,500 new members initiated. The president recommended that more care be used in the selection of the state deputy; that he should be representative of the engineers in the state, and should be in a position to give without stint of his time and efforts to build up the organization.

Owing to recent difficulties in selecting a convention city, President Johnson recommended that provision be made in the constitution to empower the national president, with the consent of the board of directors, to change the date of the convention if need be. The efforts made by the association to defeat that part of the Reclassification Bill changing the name of engineers to "enginemen" were reviewed and an appeal made to continue the fight against it. To improve attendance at the state conventions the president recommended earlier preparation of the program, so that meetings might be properly advertised. He suggested also that mechanical exhibitions should be a feature of these conventions wherever possible and that any receipts left over should be given to the state association as an educational fund or to defray the traveling expenses of officers on visits of encouragement to the different locals in the state. He approved the payment of mileages when possible.

He urged that the educational work be carried on along the same lines as in the past, that it be made more effective, and that the board of directors consider the appointment of a permanent salaried educational secretary, the results of their considerations to be presented at the next convention. In regard to license laws, Mr. Johnson said there had been little activity. Attention was called to the data in the form of laws and ordinances in the possession of the national license law committee, which are available to help advance the cause. Work of the membership extension committee was described as having been effective; the work this year was limited to the association's various chambers instead of including the manufacturers' associations approached during the previous year.

Recommendation was made that the committee revising the "Five Years Questions and Answers" be reappointed to complete the work and that an appropriation of $100 be set aside for their use. It was suggested that the printing be done in pamphlet form, subdivided as follows: Boilers; engines; refrigeration; electricity; heating and ventilation; thus, one or all five pamphlets could be secured as desired at nominal expense.

To more equitably distribute the funds set aside for state deputies, the president recommended that each be limited to an expenditure of $100. To keep expenditures within income, a maximum mileage allowance of seven cents per mile for this convention was recommended, although this



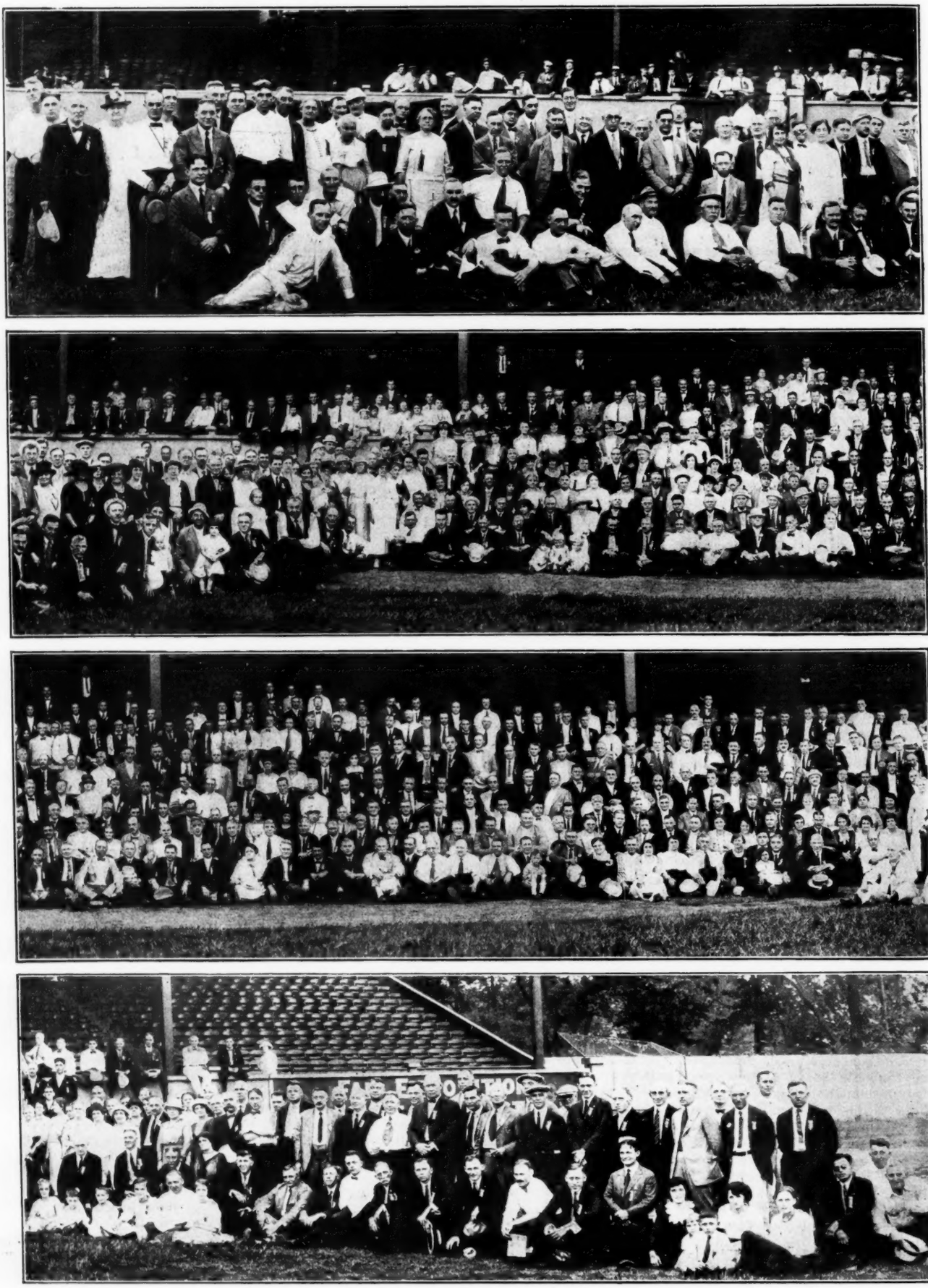
RICHARD W. PARRY, THE NEW PRESIDENT

was voted down and a nine-cent allowance adopted. A budget for 1921-22 totaling $38,600 was proposed.

R. W. Parry, national deputy, reported the institution of twelve new associations, the reinstatement of five more and two consolidations. Three charters have been returned and five associations dropped. From reports sent in, there are 19,367 members, exclusive of the state of Texas, and 17 subordinate associations in other states. Reports of the secretary and treasurer showed the association to be in a flourishing condition.

The educational committee recommended that its work be continued along much the same lines as before, with close co-operation between local and state associations and the engineering schools of the respective states. A full-time educational secretary at the earliest date practicable was recommended. One of the features of the work of the membership extension committee was the sending out of a questionnaire. A full summary of the replies was given.

The license committee reported that, although every state legislature except that of Alabama had met during the last year, only two had received petitions presented by the



THE OFFICIAL CONVENTION PHOTOGRAPH, SHOWING THE DELEGATES WITH THEIR FRIENDS AND RELATIVES

N. A. S. E. The Michigan bill, not having the co-operation of the majority of the associations in the state, was withdrawn, and in Vermont the bill was killed in the house of representatives. Several state license committees, particularly in Massachusetts and Minnesota, were called upon to do effective work to maintain existing laws.

The success of the fuel meeting at Cincinnati led the technical papers committee to recommend that one evening of the convention be devoted to one of the papers on the program. Engineers who could not attend in the daytime might be present and, with a proper choice of subject, power plant owners might be interested as well. The advantages are evident. The convention proceedings would permit the presentation of four papers and the welfare discussion.

During the last year the work of the power plant cost committee went for nought. Although prizes had been offered for the best article on the subject, there had been no response. The topic is vital at the present time and it was felt that it should be given every attention. A paper on "Modern Passenger Elevators," by W. E. Cory, was received with a great deal of interest, and during the afternoon a boat ride on the Ohio River provided the necessary relaxation.

Wednesday's Session

Wednesday was manufacturers' and employers' day at the mechanical exposition. At the second business session, held during the morning, W. J. Reynolds recounted his experiences in Washington when presenting the objections of the engineers to the Reclassification Bill. The International Union of Engineers, the Marine Engineers and the United States Government engineers had co-operated, following the lead of the N. A. S. E.

In complying with a request for an expression from the convention on the resolution calling for a change in the name of the association to the National Association of Engineers, it was the consensus of opinion that the time was not opportune, owing to the fight against the Reclassification Bill, that it would be expensive to change, and that the name suggested was already copyrighted and therefore could not be used. A vote decided the question in the negative.

The morning session ended with a paper by Henry Kreisinger on what the Bureau of Mines had done for the power plant engineer. The speaker reviewed both the educational and research work of the Bureau, with lantern slides of equipment used and results obtained. Analyses of coal, research work on combustion and results obtained with powdered coal were carefully reviewed. The paper was well received and there were many questions to answer, particularly on powdered coal.

During the afternoon the annual field sports were held at Bosse Field. The engineers won the ball game from the exhibitors by a score of 8 to 4. There were races of various descriptions, a tug of war and the final event—the taking of the official convention picture, which spread out to such a length that it is reproduced here in four parts.

Wednesday evening the life and accident department held its annual meeting. Chairman Judson Pratt declared that the department was on a splendid basis, the reserve now exceeding $7,000. He emphasized the low cost of insurance and made the plea that there be more activity in interesting eligible members. Secretary Taylor presented a full report for the year and among other things showed an increase in membership for the department of 45, the total on Sept. 1 last being 3,386.

On Thursday morning the committee on analysis and distribution recommended that only two papers be read at future conventions. The mileage committee reported a total mileage for delegates of 252,843 miles, which, at the rate of nine cents a mile, amounted to $22,755.87. Several referendum proposals calling for minor changes in the constitution were made, but subsequently were turned back to the committee for classification. The Board of Trustees reported a total of $29,016 for the year turned over to the association by the official paper, the *National Engineer*. The Board requested that they be permitted again to expend for betterments a sum not to exceed 10 per cent.

In a paper on "Unaflow and Poppet Valve Engines," G. A. Cooper, of the Hooven, Owens, Rentschler Co., reviewed the history of the unaflow engine, outlined the principles of operation, illustrated the construction and pointed out advantages. Owing to its economy and flat steam curve, emphasis was placed on the adaptability of this engine to steel mill service.

A box of oranges from the California contingent put the delegates in an excellent frame of mind to receive the annual visit of the National Ladies' Auxiliary. The ladies reported six new locals and the addition of six pensioners during the year. Total receipts of $5,586.57 made it the greatest year ever. The usual donation of $100 was made by the Association. The annual memorial services ended the session.

John W. Lane opened the afternoon session by introducing the topical discussion "Being Known in Your Own Home Town." Get into the daily press and Chamber of Commerce papers by getting acquainted with the editor and learning from him what would be available and how to prepare it. The individual who writes the material will become better known and not only benefit himself but the organization with which he is connected. Such was the consensus of opinion. The topic proved of exceptional interest and many took part in the discussion, telling what their organizations had done in their home towns.

Prof. A. A. Potter of Purdue University followed with a talk on co-operation between technical institutions and the associations of the N. A. S. E. in respective states, enlarging particularly on what had been done in Indiana, where the services of 36 specialists were available for lectures on subjects of interest to engineers. Next in order was the presentation of 56 flags to those associations that had made the necessary increase in membership.

The New Officers

Following routine business Friday morning the big event of the day was the election of officers, which resulted as follows: President, Richard W. Parry, Cincinnati; vice-president, Frederick Felderman, New York City; secretary, Fred W. Raven, Chicago; treasurer, Samuel B. Forse, Pittsburgh; trustee of *National Engineer* for five years, Joseph O'Connell, Chicago; conductor, Samuel Clark, Jersey City; doorkeeper, Charles Streithof, Evansville. Friday evening the newly elected officers were installed at the Hotel McCurdy.

Des Moines, Iowa, was selected as the convention city for 1922.

Officers of the National Exhibitors' Association for the ensuing year are: President, Frank Martin, Jenkins Bros.; vice-president, Hudson Dickerman, Johns-Pratt Co.; secretary, F. N. Chapman, A. Leschen & Sons Rope Co.; treasurer, Warren France, France Packing Co.; executive committee, G. R. Roland (chairman), Texas Co.; E. E. Jones, U. S. Rubber Co.; S. E. Hilton, Chapman Valve Mfg. Co.; J. C. Stout, Crandall Packing Co.; W. R. Lyons, Johns-Manville Co.

The National Ladies Auxiliary elected the following officers: President, Catharine Bastian, Chicago; vice-president, Sophie Legner, Cincinnati; secretary, Lenore W. Farmer, Columbus; treasurer, Mary T. Mahon, Chicago; conductor, Carrie Streithof, Evansville.

The Australian Federal Government has agreed to remit the customs duty on all machinery for state works which cannot be manufactured in the commonwealth, according to the *Engineer*. This will have especial significance in hydro-electric development, which now requires the importation of large amounts of machinery from England and America.

Dynamos and generators to the value of $7,937,935 were exported by the United States during 1920, according to figures of the Bureau of Foreign and Domestic Commerce. It is interesting to note that Japan's share of this business was $1,402,984, or almost twice as much as that of any other country.

Washington News

Another Offer Made for Muscle Shoals Project—Great Unemployment Among Coal Miners—Admiral Griffin Retires

By Paul Wooton
Washington Correspondent

Details of the offer of C. E. James, of Chattanooga, Tenn., to take over the Muscle Shoals water power project and the nitrate plants have been given out by the War Department. The following constitutes the entire contents of two letters addressed by Mr. James to the Secretary of War:

First, I will pay for the general plants, land and material at Muscle Shoals, Sheffield, Alabama, five million dollars. Second, for rent on Wilson Dam and Dam No. 3, I would pay the following amounts for a 97-year lease: [The amounts range from $1 to $6.50 per year per average horsepower.]

All taxes on government property and equipment to be paid by the Government. I would not ask the Government to guarantee any specified amount of power; I would want them to put in the electric equipment capable of producing 400,000 hp. If the Government put in additional dams above Muscle Shoals in the Tennessee River to aid navigation, all the way to Chattanooga, to a boating stage of 9 feet and 6 feet, Chattanooga to Knoxville, the horsepower would run to 800,000 at Muscle Shoals. If so, the Government would receive rental on 800,000 hp., the Government to have the right to equip the plant to 800,000 hp., if it decided to do so—I to take the increased power as produced at above rates.

The concrete foundations in dams ought to be made capable of installing a total of 800,000 hp. machinery, but only install 400,000 hp. now, Government to have free 300 hp. current to operate lock gates. I would operate nitrate plants for fertilizers on a basis of 8 per cent profit, and keep in good condition Plant No. 2, subject to be turned over to the Government in case of emergency.

I would like to have the option, if my proposition is accepted, but not to be embodied in contract, the right to build a high dam for power and storage in the Clinch River at some point near Kingston, Tenn., so as to increase the flow of water at Muscle Shoals, and also to take care of loss of current on wire line, and make the electric current more regular between Muscle shoals and Kingston, Tenn.

With conferences in progress between the Secretary of War and the engineers in the employ of Henry Ford in regard to the acquisition of the Muscle Shoals project, it is believed that a definite pronouncement of the administration's policy in this particular may be expected in the near future. Since the disposal of Muscle Shoals would involve legislation, however, no final solution of the matter can be expected for some time to come.

Coal Miners Out of Work

Unemployment among coal miners will constitute one of the major subjects of discussion at the forthcoming conference that will meet in Washington in response to a call by Commerce Secretary Hoover. Unemployment at coal mines during the first eight months of 1921 sets a new low record. It was even greater than during the period following the panic of 1893, which previously held the low record. Twenty-six per cent less work was performed in coal mines during the first eight months of 1921 than during the corresponding period of 1920. Enough information already has been gathered, in anticipation of the conference, to indicate that approximately 150,000 men, who are coal miners by trade, are not now engaged in that activity. No figures are available to indicate how many of these men have been absorbed by other employment. In some of the coal mining districts there is other work to which miners may turn, but in most of the districts this is not the case. Some of the information, already gathered, shows that a great many miners have been idle, living on their savings or on their credit, awaiting an improvement in the demand for coal.

Robert Stanislaus Griffin, for more than eight years the head of the Bureau of Engineering of the Navy Department and engineer in chief of the United States Navy, ended his long period of active service on Sept. 22 and retired to private life. The use of electric propulsion on battleships was put into effect many years earlier than would have been the case had Admiral Griffin been a less determined champion of that type of drive. There was strong opposition to what was termed experimentation with a vital feature of a fighting ship. Admiral Griffin, however, did not recommend the electric drive until he had made the most careful study of its application on the collier Jupiter. Now that the superiority of electric propulsion is conceded, Admiral Griffin retires with the full satisfaction that his judgment has been vindicated. The admiral is an honorary member of the American Society of Mechanical Engineers, and has received several degrees and medals.

Electricity in the Chemical Industries*

By D. B. Rushmore, J. A. Seede and E. Pragst

As the chemical engineer develops processes and determines the electrical requirements, there devolves upon the electrical engineer the responsibility of designing the electric installations to meet these electrical requirements.

Irrespective of the product or the location of the plant, it is necessary to secure an ample and uninterrupted supply of electrical energy. Whether this power is purchased from a public utility or generated in a station owned and operated by the industry is a purely economic consideration, assuming of course, that it is possible to purchase the same class of service as can be secured from a plant built and operated by the industry to meet its particular requirements.

Continuity of service is essential. In some industries an interruption in service results only in a loss of production and labor during the time of interruption; in others an interruption will result (in addition to these losses) in a depreciation or even total loss of the material in the process of manufacture at the time, and in some cases even to serious damage to the apparatus used in the manufacturing process.

When a plant is built by the industry, there is often the possibility of choice between developing a hydro-electric site or installing a steam plant. In those processes where little or no low-pressure steam is used, one can almost invariably justify the construction of a hydro-electric plant where a reasonably favorable site, having good physical characteristics, stream flow and water storage, is available. It is also possible, in those processes using large quantities of low pressure steam, to generate power from coal or oil very economically, for one may extract low-pressure steam for process purposes from intermediate turbine stages. In such cases we convert to electrical power a large proportion of the energy available in this steam for conversion to this form of energy and at the same time retain for process work the latent heat of the exhaust steam which goes normally to the condenser in straight condensing plants. Crediting the cost of power generation with the heat in the steam extracted, a very low ratio of fuel to kilowatt-hours produced results with a corresponding lowering of the cost of power generation.

Steam-Electric Generating Station Practice

Up to the present time as a result of the increasing price of fuel, steam-station designers have been striving for increased thermal efficiencies. We probably reached the maximum of vacuum some years ago, so there is but small possibility of increasing station economies through improvements in vacuum. Recent developments have been in the line of employing higher steam pressures and superheat, thereby bettering the thermal efficiency of the turbine. Through the employment of efficient and carefully selected stokers, economizers, air heaters, etc., and through the utilization of a counterflow principle, it has been possible to secure a more efficient combustion and a reclamation of a larger proportion of the heat produced as result of the fuel combustion. Also, very careful consideration has been given to the station heat balance to utilize the maximum amount of the heat in the exhaust from the station auxiliaries and pass a mimimum amount of heat to the condenser of the main units.

*Extracts of a paper read before the National Exposition of Chemical Industries, New York, Sept. 16.

With steam at high pressure and superheat come added problems which materially influence station design. It has been common practice up to recent years to drive all or most station auxiliaries by steam and use the exhaust from these auxiliaries for heating feed water. It is neither practicable nor desirable to distribute steam at high pressure and temperature to steam-driven auxiliaries. It would also be difficult and costly to build and maintain small turbines to operate under such conditions. A solution has been found in motor drive for station auxiliaries, and most of the large new stations are adapting this principle for driving the greater part of auxiliaries.

Heat Balance

In some stations power for driving the electrically driven auxiliaries is taken from the main generator bus and this voltage stepped down through suitable transformers for distribution to the auxiliaries. A proper station heat balance is maintained by steam from the intermediate stages of the main turbines. A possible criticism of this method of operation is the possibility of interrupting the operation of all electrically driven auxiliaries in the case of a short-circuit that lowers the main bus potential. To guard against this possibility of service interruption, a second but more costly method of supplying power for auxiliary drive has come into general use. This consists in using one or more turbo-generators of the capacity required to furnish energy to the auxiliaries. These units are usually known as house turbines, are used with jet condensers, and the generators connected to a special bus off which the auxiliaries are fed. The condensate from the main units plus any required makeup water is used for condensing the exhaust steam from the house turbo-generator, or conversely, the exhaust from the house turbo-generator is used for heating the feed water. By varying the load and vacuum on the house turbine as result of changing the divisions of load between it and the main station bus, any predetermined feed-water temperature can be maintained irrespective of the station or auxiliary load.

Up to the present time designers of large steam-electric generating stations and apparatus used therein have been striving for station thermal efficiency, but at the expense of station simplicity and with an increased cost of installation and corresponding increase in fixed charges and maintenance. We are arriving at the point where some critics have suggested that we are reaching the stage where the resultant coal saving from increased thermal efficiency might be offset by the increased fixed charges and maintenance costs. We are already approaching the maximum temperatures and pressures to which it is thought desirable to subject our present materials. It is doubtful that any further substantial economies are expected with our present method of conversion of the potential energy of our fuels into electric power through steam.

Various investigators have been working on methods for decreasing the cost of electric-power production from fuel through the bettering of the thermal efficiency of the cycle without materially increasing the fixed charges, maintenance and operating costs of the conversion apparatus. One of the most promising of these has been the experiments carried out from time to time on the mercury boiler and turbine. Briefly, these have been based upon increasing the range in temperature of the thermal cycle by generating relatively low-pressure but high-temperature mercury vapor and expanding it through a special turbine, then using the exhaust mercury vapor for steam generation for use in standard-type steam turbo-generators.

A "Safety riddle" has been devised by Frank Morris, manager of the Syracuse Safety Council, who asks, in the *National Safety News*, what the word "Caton" means. The answer, "It doesn't mean anything if U and I stay out," seems a rather neat way of expressing it.

A bill recently signed by President Harding grants Federal recognition to the 1925 exposition that is being planned for Portland, Ore., in celebration of the centennial of the invention of the electro-magnet. The exposition will deal very largely with hydro-electric developments, especially in the Western States.

Superpower System in Its Relation to National Economy*

This country is suffering from a severe industrial depression, necessitating economy, not only by the Government, but by each individual citizen. This is not the first depression we have had to live through following a great war. The Civil War brought as its aftermath the same results, but, unfortunately, we cannot follow in the footsteps of our fathers in overcoming the present depression and in building for future business, for their problem was vastly different and simpler than that which today confronts us.

At the termination of the Civil War the large majority of our people followed agricultural pursuits, and our manufacturing industry was in its infancy. The opening of the public land, the development of our mineral resources and the lumbering of our forests furnished employment not only to all our own people, but to all emigrants from other lands that could be induced to come into this country.

Then we were a debtor nation, importing a large amount of manufactured articles for which we partly paid by exporting raw materials for use in Europe. Large amounts of capital were required for the exploitation of our mines, our forests and the transportation systems which were needed to make the development of these natural resources possible, and Europe was glad to supply this capital to us from her accumulating funds. By the end of the present century, however, we were developing into an industrial nation. We were starting to convert a large part of our raw materials into finished product, but even by 1913 our manufactures had not become our predominating industry and our commercial contact with the rest of the world was limited.

Effect of the World War

The World War effected a tremendous change. Europe could not produce instruments of destruction fast enough and contracted here for large supplies, paying principally with American securities and thus liquidating our long-standing debt. When we got into the war, it was necessary not only to finance ourselves, but to aid our allies both with money and with supplies; so we not only became her creditor, but at the same time developed and constructed enormous factory facilities—as a matter of fact far greater than are required to supply our own needs for many years to come.

Thus, to keep our factories operating at full time, it is necessary for us to sell their excess production over our own requirements in the markets of the world and to meet the competition of other industrial nations in that field. We are Europe's creditor to the extent of nearly $15,000,000,000. Our manufacturing industries have developed to the point where we must look beyond our domestic markets to keep them busy. Our nation has changed from one in which the majority of the people are engaged in agricultural pursuit to one where they are dependent on our factories for prosperity. Our resources have been fairly well developed, and we cannot now take a large influx of emigrant labor. In fact, we must restrict it for the time being, so that our people may be provided with work. We cannot go to Europe for capital. We must furnish what we need ourselves, through thrift and economy; in fact, we should be able to lend Europe more than we have, for our commercial good.

Europe's debt to this country in Government loans and commercial paper stands today at about $15,000,000,000. She cannot liquidate this debt, or even pay interest on it, with gold, for today we own the greatest part of the gold available, while her gold reserves are at low tide. She must pay us with goods imported to this country in the same manner that we met our obligations to her by export in the years preceding the World War. In this, the low exchange rate resulting from the war becomes an advantage. So in order to keep our factories running at full production, we must not only be able to meet this competition in the world's market, but must compete with it within our own domestic market. This is the situation that calls

*Abstract of paper delivered by Henry Flood, Jr., at Newburgh, N. Y., Aug. 16, 1921.

for a program of national economy; and it means governmental economy to reduce taxes, economy in capital expenditures to reduce overhead, and labor to reduce operating costs.

While in the past we have not had to compete with foreign products in the sense we now do, we have been successful in such competition by our ingenuity in supplementing the expensive man power with cheap machine power, and that principle will furnish one answer to our present difficulties. There is a direct relation between the amount of machine power used per wage earner and the value of products which he produces. In 1899 we were using 2.1 hp. per wage earner, with a resulting value of products of $2,400. By 1914 we had increased the amount of machine power supplementing our man power to 3.2 hp. per wage earner, and the value of products had correspondingly increased to $3,400. From these figures it can be seen how much more productive a man can be made by supplementing his efforts with power.

Of all the European countries England leads in the use of power as an adjunct to labor. In 1907, the year of the last industrial census for Great Britain, that country was using 1.5 hp. per wage earner against our 2.7 and the value of her products was only $1,200 per wage earner as against our $2,950. Thus, while using 1.8 times more power per wage earner than was England, we were producing products 2.4 times the value of their products.

Necessity of Increasing Use of Power To Aid Labor

So if we are to progress and participate in our share of the world's market, we must place ourselves in the position of being able to compete with European labor by increasing the amount of power that we give each wage earner to supplement his own efforts, and we must not stop at any figure of three horsepower, four horsepower, but must carry it high enough to wipe out the difference in the labor wage paid here and abroad. This is the object of the Superpower project.

The Superpower System, as now known, is merely the expansion of what has been taking place within the utilities for a number of years past, making it apply to a larger section of the country in order to derive the utmost benefit from financial and engineering skill. The territory embraced in the Superpower zone contains only about 2 per cent of the land area of the United States, but in it live 22 per cent of the total population, who use more than 35 per cent of all the power and more than 40 per cent of all the coal produced in the country. The electric utilities within this zone, of which there are 315, have about 4½ million kilowatts of generating capacity installed and produce 10 billion kilowatt-hours per annum. There are 96,000 industries of which 76,000 use power, producing about 9 billion kilowatt-hours in addition to that generated by the utilities. The heavy-traction railroads own 36,000 miles of track within this territory.

These figures show the extreme congestion of this territory. It is, in fact, the finishing shop of America, into which the raw products from other sections of the country flow for fabrication and from which the finished products must be distributed not only to the rest of the country, but to the foreign markets.

Results Predicted with Superpower System

Today our electric utilities in the zone are operating power plants averaging 7,900 kw. in capacity, which use about 2.73 lb. of coal with a production cost of 1.9c. per kw.-hr. By the installation of steam-electric plants of the magnitude of 300,000 kw. and of hydro-electric plants upon the least expensive rivers for development, the Superpower System will raise the average size of the plant from 7,900 kw. to nearly 40,000 kw., with the consequent reduction in the investment from $196 to $136 per kilowatt. The fuel consumption will be reduced from 2.73 lb. per unit to 1.62 lb., while the production cost of power will be reduced from 1.9 to about 1.1c. per kw.-hr. By 1930 it is estimated that the total electrical load of the zone will have grown from 10 billion to 30 billion kilowatt-hours, including the railroad electrification, while the generating capacity needed will have increased from 4,500,000 to about 8,000,000 kilowatts.

Comparing the results that can be obtained by the Superpower System in 1930 with that of independent operation of 1919 gives astounding results. After providing for amortization of all abandoned property, these electric utilities show an annual saving of $240,000,000, the industries of $190,000,000 and the electrified portions of the railroads of $82,000,000, a total of $512,000,000 per annum. To obtain this tremendous saving, a total investment of over $1,000,000,000 is required for the utilities, of which about $400,000,000 is in present facilities, making $700,000,000 of new money required. However, were the same utilities expanded independently rather than co-operatively as through a superpower system, about $860,000,000 would be required, so we have a conservation of capital of about $160,000,000 from this item alone. To motorize industry will require another $185,000,000, while to electrify the 19,000 miles of railroad will take about $540,000,000. To develop independently the same capacity in industry and railroads would require considerably more capital.

Altogether, then, the total new money required to accomplish all this by 1930 is about $1,325,000,000, through which expenditure we will be able to save over $500,000,000 per annum, which is a return of about 38 per cent on this money. That should be attractive enough to interest not only the business man, but the people at large. Not only do we conserve capital and labor by such a system, but we conserve our natural resources such as coal, as the total saving in coal over the independent operations by the Superpower System in 1930 will amount to nearly 50,000,000 tons per annum.

Sources of Saving by Superpower System

In the utilities the saving comes from three sources:

1. Quantity production by large power plants, by which coal consumption is reduced one-half, labor consumption and maintenance to one-third, and capital invested by nearly 50 per cent.

2. Joint reserves. Today each property must provide sufficent reserve in plant equipment to protect its customers under the worst conditions. The maximum load of the different sections of the country fall at different times, and by using joint reserves available to the different sections, the total investment is materially reduced, resulting in lower cost of production.

3. By the utilization of water power. Water power today contributes only about 15 per cent of the total power developed in the zone. Water powers as a rule are expensive to develop, and unless there is a very large market it is economically impossible in many cases to finance them. The Superpower System affords a broad market under which conditions water powers that previously could not be successfully financed, could under those conditions be developed.

The idea prevalent to the average layman is that there is an unlimited supply of water power in every section of the country. This must be abandoned, for such is not the case, and even by 1930 the use of water power would hardly grow to more than 20 per cent of the total. However, should the efforts of the Great Lakes-St. Lawrence Tidewater Association, which is endeavoring to develop navigation and power on the St. Lawrence, be successful, there should be available, by 1932 or 1933, enough additional water power to bring the ratio up to about 33 per cent of the power produced.

In industries the saving results principally in the lower cost of power to manufacture, and secondly, in a lower investment, in that the money spent can be limited to motors instead of to steam-power plants, thus releasing the capital for utilization for direct production purposes.

During periods of expansion and prosperity the development of our transportation systems and utilities has always preceded that of manufacturing and other industries, so that when these industries had need for the transportation of their product or for the power with which to produce it, such facilities were on hand. We must recognize that the utilities and railroad are agencies of prosperity, and we must encourage them by permitting them such a return upon their investment that they can go out into the market and compete for money, not only with the securities of industry, but with those of the Government as well.

Business Items

The Northern Equipment Co. has appointed the Ernest E. Lee Co., 115 South Dearborn St., Chicago, as its district representative in the sale of Copes boiler-feed regulators and pump governors.

The Howard Iron Works and the Alberger Heater Co., manufacturers of expansion joints and heaters, now have offices at 1777 Woolworth Building, which are in charge of S. D. Harding and G. S. Whiffen.

The Batterman-Truitt Co., 736-738 West Monroe St., Chicago, Ill., manufacturer of fans and blowers, has changed its corporate name to the Autovent Fan and Blower Co. Only the name has been changed, the same officers remaining and the same address being retained.

The Quaker City Rubber Co., manufacturer of Daniel's P. P. P. rod packing, ebonite sheet packing, ironsides rubber belting etc., is to move into its new Quaker Building, 624-26-28 Market Street, Philadelphia, on Nov. 1. The new building will house the main offices and salesrooms.

The Elliott Co., Jeannette, Pa., has moved its Philadelphia district office from the Pennsylvania Building to 812 Morris Building. T. F. Crawford is in charge of the office. It has been announced also that W. Wilder, formerly with the Steel and Tube Company of America and the Allis-Chalmers Mfg. Co., has been appointed to the Pittsburgh office.

The Associated Commercial Engineers, 96 Fifth Ave., New York, N. Y., is a consolidation recently effected between C. R. Rothwell, a member of the A. S. M. E., and M. William Ehrlich, of the A. S. H. V. E. The new firm will deal with pumps, traps, valves and other mechanical equipment for plants and buildings, and has been appointed exclusive representative in the Metropolitan district by the Trane Co., of La Crosse, Wis.

New Publications

FURNACE DESIGN

The W. S. Rockwell Co., 50 Church St., New York City, comprising furnace engineers and contractors, has prepared a short booklet entitled "The Variety of Furnace Design," consisting mainly of diagrammatic drawings of different types of furnaces for industrial heating. It is bulletin No. 232 and is the third of a series on industrial heating.

CONDENSING EQUIPMENT

The Wheeler Condenser and Engineering Co., Carteret, N. J., has issued a new general catalog which illustrates and describes a complete line of condensers and accessories for stationary and marine service, including Wheeler condensers, vacuum-pumps, centrifugal pumps, cooling towers, condenser tubes, feed-water heaters, etc. Of especial interest is the description of a new design of 26-in. vacuum surface-condensing equipment adapted for engine work and dispensing with combined auxiliary pumps. A condenser data sheet is included with each copy.

STEAM BOILERS. By Terrell Croft. Published by McGraw-Hill Book Co., Inc., New York City. Cloth, 6 x 9 in.; 397 pages; 511 illustrations.

The book is primarily for engineers who have had but little schooling and therefore it deals with the steam boiler and its accessories in an elementary manner. Much of the contents are descriptive of the several types of boilers in general use, as well as some of obsolete pattern. Of special interest is the chapter dealing with the stresses in a boiler shell. A considerable amount of space has been given to interpretations of the A. S. M. E. Boiler Code, which has been largely adopted by the several states. The volume has much to commend it to the engineer who is preparing for a license examination and to those who are not in touch with modern boiler developments.

Trade Catalogs

The Hi-Voltage Equipment Co., 3305 Croton Ave., Cleveland, O., has issued a new bulletin, No. 2, on lightning arresters, choke coils and fuses for high-tension service.

The Bailey Meter Co., 2015 East 46th St., Cleveland, O., is distributing Bulletin No. 6, which describes briefly a line of meters for recording the flow of fluids, gas and granular materials.

The Dayton-Dowd Co., Quincy, Ill., has prepared a new bulletin, No. 246, dealing with its centrifugal fire pump units, which are driven by gasoline or electric motor, or both, and are built in 3 or 5 hp. sizes.

The Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., is distributing a circular describing the Yarway double-tightening lever-operated valve for soot blowing systems and blow-off and other uses.

Smith & Serrell, Central Ave. at Halsey St., Newark, N. J., is distributing a new bulletin describing the Francke flexible coupling, for use with direct-connected machines. Several pages are devoted to practical suggestions for installing and aligning machinery.

The American District Steam Co., North Tonawanda, N. Y., is distributing a 6 x 9 in., 178-page catalog, No. 21, which is well gotten up in cloth covers. The company manufactures pipe, special fittings, expansion devices, insulating materials and other products for central station heating systems.

The Metals Coating Company of America, 495-497 North Third St., Philadelphia, Pa., is sending out a booklet describing the Schoop metal spraying process, used principally to protect the coated material from corrosion. The instrument used is described as "A machine-gun making its ammunition from reeled wire and coating objects by bombarding them with minute plastic particles of metal."

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Sept. 13, 1921	Sept. 20, 1921
Pool 1,	New York	$3.40	$3.00@3.50
Pocahontas,	Columbus	3.15	2.65@2.85
Clearfield,	Boston	1.95	1.65@2.20
Somerset,	Boston	1.75	1.45@2.00
Pittsburgh,	Pittsburgh	2.25	2.20@2.25
Kanawha,	Columbus	2.15	2.00@2.25
Hocking,	Columbus	2.15	2.00@2.25
Pittsburgh No. 8	Cleveland	2.25	2.05@2.20
Franklin, Ill.,	Chicago	2.95	2.25@3.50
Central, Ill.,	Chicago	2.40	2.00@2.75
Ind. 4th Vein,	Chicago	2.55	2.00@2.75
Standard,	St. Louis	1.95	1.85@2.00
West Ky.,	Louisville	2.25	2.05@2.40
Big Seam,	Birmingham	2.15	2.00@2.25
S. E. Ky.,	Louisville	2.15	2.00@2.35

New York—On Sept. 21, Port Arthur light oil, 22@25 deg. Baumé, 4¼c. per gal. 30@35 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

Chicago—Sept. 10, for 24@28 deg. Baumé, 40@45c. per bbl.; 32@36 deg. 1¼@1¾c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Sept. 19, f.o.b. refinery; Pennsylvania, 36@40 deg., 3½ to 4c; Oklahoma, 24@30 deg., 50@55c. per bbl.; gas oil, 32@34 deg., 1¼c. per gal., 36@38 deg., 1½c. 38@40 deg., 1¾c.

St. Louis—Sept. 17, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 45c. per bbl.; 26@28c. deg., 55c.; 28@30 deg., 60c.; 32@34 deg. 1¼c. per gal.

Philadelphia—On Sept. 19, 26@28 deg. Baumé, Oklahoma, 45c. per bbl.; 30@34 deg., Oklahoma (group 3) 70c. per bbl.; 16@20 deg. Seaboard, 3c. per gal.

Cincinnati—Aug. 31, for 22@28 deg. Baumé, 3c.; Diesel, 26@30 deg., 2¼c. per gal.

Cleveland—Aug. 31, for 22@28 deg. Baumé, 5c. per gal.

New Construction

PROPOSED WORK

Mass., Everett—The City Bldg. Committee is having plans prepared for a 3 story high school on Bway. About $750,000. Ritchie, Parsons & Taylor, 15 Ashburton Pl., Boston, Archts.

Mass., Newton — Maginnis & Walsh, Archts, 100 Boylston St., Boston, will soon award the contract for a 3 story, 75 x 180 ft. science building on Commonwealth Ave. and College Rd., for Boston College, W. Devlin, Chestnut Ave., Pres. Cost between $400,000 and $500,000.

R. I., Providence — The State Penal & Charitable Comn. will soon award the contract for two 3 story ward buildings at the state infirmary in Cranston, including a steam heating system. About $300,000. G. F. Hall, 806 Union Trust Bldg., Archt. Noted March 29.

N. Y., Buffalo—The Comn. of Parks & Buildings, Municipal Bldg., will receive bids until Oct. 4 for an electric driven grain elevator, with motor connections, etc.

N. Y., New York—J. Golding, c/o Rouse & Goldstone, Archts., 512 5th Ave., will soon award the contract for two 4 story apartments on 90th St. and Bway. About $750,000 each.

N. Y., New York—McNutt, Watts & Tanker, 9 Great Jones St., are in the market for a 1 hp., 3 phase, 40 cycle motor, 230 volt, complete with pulleys.

N. Y., New York—L. Weiss, 299 Bway., plans to build a theater on Lenox Ave. between 139th and 140th Sts. About $500,000.

N. Y., Perrysburg—The City of Buffalo, Municipal Bldg., Buffalo, received bids for a hospital from J. W. Cowper Co., Fidelity Bldg., Buffalo, $689,000; C. H. Everitt, 295 Auburn Ave., Buffalo, $698,000; and Harding & Crea, White Bldg., Buffalo, $704,000.

Pa., Philadelphia—The Dept. of Transit, 1211 Chestnut St., W. S. Twining, Dir., will receive bids in about 60 days for a 40 x 60 ft. sub-station on Cumberland and Kensington Aves. and one 40 x 70 ft. on Griscom and Arrott Sts. Equipment including 2 signal transformers, switchboard, etc. will be installed in same. H. H. Quimby, 1211 Chestnut St., Engr.

Pa., Philadelphia — Maginnis & Walsh Archts., 100 Boylston St., Boston, are receiving bids for a 1 story church, including a steam heating system, on Kensington Ave., for the Holy Name of Jesus Church Beks and Gaul Sts. About $250,000.

D. C., Washington—The Bureau of Yards and Docks, Navy Dept., received bids for alterations and additions to the heating system at the Naval Hospital from Carroll Electric Co., 714 12th St., N.W., $28,600. W. G. Cornell Co., 723 13th St., N.W., $31,452, and The Federal Htg. Co., 310 13th St., N.W., $34,575. Noted Sept. 6. Spec. 4510.

Tenn., Memphis — Rogan & Weller, Archts., Bank of Commerce Bldg., will receive bids until Sept. 30 for a 6 story club building, on Adams and 3d Sts., for the Catholic Club Bldg. Assn., E. F. Longinetti, Secy. About $500,000. A contract for the steam heating system will be awarded separately on the same date.

Tenn., Nashville—The city, P. Treanor, City Water Comr., plans election to vote on $1,800,000 bonds for waterworks improvements, including force main, booster station, filteration plant, repairs to reservoir, installation of boilers and mechanical equipment, etc. S. H. McKay, City Hall, Secy. Bd. of Pub. Wks.

O., Alliance—Theo. Misterski, 1606 South Union Ave., is in the market for a small water turbine.

O., Cincinnati — The Norton Broadway Mchy. Co., 236-8 Bway., W. D. Norton, Purch. Agt., is in the market for 2 belt driven 750 gal. per min. underwriters' fire pumps and a portable fire box boiler, 100 hp., good for 40 or 50 lbs. steam pressure (used).

O., Cleveland—The Bd. of County Comrs., Court House, will vote Nov. 9 on a bond issue for $2,000,000 for a 4 story county jail on West 3d St. and Lakeside Ave. W. L. Longee, Marshall Bldg., Archt.

O., Cleveland — The Cleveland Electric Illuminating Co., Illuminating Bldg., is having plans prepared for a 2 story, 26 x 60 ft. sub-station on East 17th St. About $40,000. M. S. Galaher, Illuminating Bldg., Archt.

O., Elyria—The city will soon receive bids for waterworks improvements, etc. C. W. Tarr, Engr.

O., Middletown—The Middletown Hotel Co., J. A. Aull, Acting Chn., is having plans prepared for a 5 story hotel. About $400,000. F. L. Packard, New Hayden Bldg., Columbus, Archt.

O., Painesville—The city received lowest bid for a 60 x 48 ft. power plant from the Service Constr. Co., 6110 Euclid Ave., Cleveland, $21,745. Noted July 19.

Mich., Detroit—The Detroit Police Dept., Bates and Farmer Sts., received bids for a 9 story, 117 x 172 ft. station house and a 3 story, 99 x 168 ft. armory on St. Antoine St., from O. Misch Co., 36 State St., $784,300; Bryant & Detwiler, 2336 Dime Bank Bldg., $827,843; A. A. Albrecht Co., 1130 Penobscot Bldg., $829,989. Noted Aug. 23.

Mich., Detroit — The Masonic Temple Assn., Masonic Temple, Lafayette Blvd., will soon receive bids for a 4 and 6 story, 190 x 350 ft. masonic temple, including steam heating equipment in a detached power plant, on Temple Ave. About $3,000,000. G. D. Mason & Co., 508 Griswald St., Archts. Former bids rejected. Noted Aug. 30.

Ill., Aurora—The Aurora Lodge, A. F. and A. M., c/o E. M. Birch, 197 West Park St., plans to build a 3 story masonic temple, including a steam heating system. About $300,000. Architect not selected.

Ill., Belleville—The Chief of Construction Service, Room 2242 Munitions Bldg., Wash., D. C., received bids for the construction of steel airship hangar, including boiler house, etc. at Scott Field, here, from the Sutherland Bldg. & Constr. Co., Syndicate Trust Bldg., St. Louis, Mo., $1,093,160; Sumner & Sollett, 79 East Adams St., Chicago, $1,150,000; Stang & Mitchell Co., Real Estate Trust Bldg., Phila., Pa., $1,160,000. Noted Aug. 23.

Ill., Chicago—Dubin & Eisenberg, Archts., 14 West Washington St., are receiving bids for a 3 story, 150 x 160 ft. apartment house, including a steam heating system, on Sheridan Rd. and Birchwood Ave., for Smith & Dubin. About $300,000. Noted May 3.

Ill., Chicago—Griswold & Walker, c/o A. S. Alschuler, Archt., 28 East Jackson Blvd., plans to build a warehouse, including a steam heating system, on a site between the Chicago, Burlington & Quincy R.R., Baltimore & Ohio R.R., Halsted St. and Newberry Ave. About $1,500,000.

Ill., Chicago — C. Hatzfield, Archt., 7 South Dearborn St., is receiving bids for a 3 story, 91 x 112 ft. masonic temple, including a steam heating system, on Addison and Peta Sts., for the Wrights Grove Lodge No. 7.

Ill., Chicago — The Interstate Garage Corp., H. D. Jackson, Pres., 110 North Market St., is having sketches made for a 10 story, 150 x 200 ft. garage, including a steam heating system, on Wabash Ave. and South Water St. About $225,000.

Ill., Chicago—Minchin & Spitz, Archts., 19 West Jackson Blvd., are preparing plans for a 10 story, 100 x 150 ft. warehouse, including a steam heating system, on North Shore Ave. north of River St. About $1,000,000. Owner's name withheld.

Ill., Chicago—P. F. Olson, Archt., 127 North Dearborn St., is receiving bids for a 3 story, 200 x 217 ft. apartment house, including a steam heating system, on Lake Terrace, for Anton Wille, 1200 Sherwin Ave. About $700,000. Noted May 23.

Ill., Chicago—A. S. Schulman, 440 South Dearborn St., plans to build a 21 story, 66 x 125 ft. office building, including a high pressure steam heating system, at 519-31 South Dearborn St. About $2,000,000. Architect not selected.

Ill., Geneva—The Fox River Valley Community, c/o H. T. Winsor, will soon receive bids for a 3 story hospital. About $250,000. M. J. Sturn, 115 South Michigan Ave., Chicago, Archt. Former bids rejected.

Ill., Granite City—The Cabaret Range Co., c/o A. Holloway, plans to build a range factory consisting of four buildings, including a steam heating system. About $300,000. Architect not selected.

Ill., Oak Park—The Oak Park Club, E. J. Pullock, Chn. Bldg. Comn., is having sketches made for a club building, including a steam heating system, on Ontario St. and Oak Park Ave. About $300,000. Holabird & Roche, 104 South Michigan Ave., Chicago, Archts.

Ill., Springfield—The Shrine Scottish Rite Masons, c/o A. E. Baxter, Secy., plans to build a temple, including a steam heating system. About $900,000. Architect not selected.

Ill., Valur — The Chicago, Burlington & Quincy R.R., H. Holden, Pres., 547 West Jackson Blvd., Chicago, is receiving bids for a 1 story, 14 x 20 ft. pump house and pumping equipment. About $10,000. W. T. Krausch, 547 Jackson Blvd., Chicago, Engr.

Wis., Manitowoc—The city, c/o F. L. Alter, City Hall, is having revised plans prepared and will receive bids in October for a 4 story, 210 x 360 ft. high school, including a steam heating system. About $1,400,000. Perkins, Fellows & Hamilton, 814 Tower St., Chicago, Ill., Archts.

Wis., Manitowoc—Manitowoc Eagles, c/o J. Koutnik, 1114 South Main St., will soon award the contract for a 2 and 4 story, 100 x 115 ft. clubhouse and theater, including a steam heating system, on Main St. About $250,000. W. J. Roeuber, Archt.

Wis., Racine — M. George, c/o Hotel George, Wisconsin and 5th Sts., is having plans prepared for a 10 story, 160 x 250 ft. hotel. About $600,000. A. A. Guilbert, Robinson Bldg., Archt.

Wis., Sheboygan—The Eastern Wisconsin Electric Co., c/o H. Ellis, Vice-pres., plans to build a 1 story, 60 x 200 ft. generating and power house on 8th St. About $400,000. Architect not selected, probably private plans.

Ia., Maquoketa—The Iowa Electric Light Co., Cedar Rapids, c/o Holland, Akerman & Holland, Engrs., 106 East Liberty St., Ann Arbor, Mich., is having plans prepared for a hydro-electric plant here. About $75,000.

Minn., Minneapolis—The Federal Reserve Bank, New York Life Bldg., will soon award the contract for a 5 story bank on Marquette Ave. About $750,000. C. Gilbert, 244 Madison Ave., New York City, Archt. Noted June 7.

Kan., Centralia—The city, c/o W. B. Griffith, Clk., plans to improve waterworks, including new pumping station. About $60,000. Engineer not selected.

Kan., Kansas City — The city, c/o H. Payne, Clk., will soon award the contract for a 25 x 75 ft. addition to the pumping station. About $25,000. Rose & Peterson, Baker Bldg., Engrs.

Kan., Lawrence—The Bd. Educ., c/o C. I. Stevenson, Secy., is having plans prepared for a 3 story high school. About $500,000. W. B. Ittner, Bd. of Educ. Bldg., St. Louis, Mo., Archt. Noted Sept. 20.

Kan., Leavenworth — The National Soldiers Home, c/o Capt. W. S. Albright, Bway. and Oak Sts., will receive bids until Oct. 1 for a 2 story hospital. About $1,000,000. W. P. Feth, 405 Delaware St., Archt. Noted Aug. 30.

Kan., Rosedale—The State Medical School and Hospital, c/o J. A. Kimball, Topeka, will receive bids until Oct. 1 for a 3 story, 64 x 164 ft. hospital, here. About $400,000. R. L. Gamble, 1415 Fillmore St., Topeka, Archt. Noted Apr. 26.

Neb., Madison—The city is having plans prepared for an addition to the electric light plant. About $70,000. Henningson Eng. Co., National Bldg., Omaha, Engrs.

Neb., West Point—The city, c/o S. Lindale, Clk., will soon receive bids for an addition to the electric light and power plant. About $58,000. Koenig-Hollister & Co., 401 Bankers Life Bldg., Lincoln, Engrs. Former bids rejected. Noted Aug. 30.

Mo., Kansas City—The Kelly Mill Co., c/o A. B. Kelly, Pres., Rochester and Park Sts., plans to build a flour mill here. About $500,000. Architect not announced.

Mo., St. Louis—The Rosati Kain Catholic High School, 436 Lindell St., will soon award the contract for a 3 story, 80 x 178 ft. school on Newstead and Lindell Sts. About $300,000. Noted Aug. 2.

Ark., Fort Smith—The Ft. Smith Light & Traction Co., 3d St. and Garrison Ave., D. C. Green, Genl. Mgr., is having plans prepared for an addition to its electric light and power plant on 9th and A Sts.

Tex., Austin—Pitts-Noyes Co., Inc., 112 East 5th St., H. Pitts, Pres., is in the market for 3 phase, 60 cycle, 220 volt-motors, also other equipment for use in foundry.

Wash., Port Townsend — The Treasury Dept., J. A. Wetmore, Supervising Archt., Wash., D. C., will receive bids until Oct. 12 for the installation of a lighting plant, wiring, etc., at the United States Quarantine Station, here.

Ont., Kingston — The Kingston General Hospital and the Queens University will soon award the contract for a 1 story power plant, including equipment for vacuum steam boilers, pumps, etc. About $75,000. Power, Son & Drewer, Merchants Bank Bldg., Archts.

CONTRACTS AWARDED

Mass., Worcester — Holy Cross College, Rev. J. J. Carlin, Pres., has awarded the contract for a 4 story, 108 x 113 ft. dormitory building on the Campus, to McDermott Bros., 18 Cedar St. About $300,000. A steam heating system will be installed. Noted Feb. 8.

N. Y., Amsterdam—The Mohawk Carpet Mills, Inc., 57 Lyons St., have awarded the contract for a 6 story, 56 x 60 ft. addition to their plant, to the Aberthaw Constr. Co., 27 School St., Boston, Mass. About $275,000.

N. Y., New York—The New York Steam Co., 280 Madison Ave., has awarded the contract for a steam station at 59th St. and East River, to Stone & Webster Co., 120 Bway. About $400,000.

N. Y., New York—The Sixty-seven Park Ave. Corp., c/o Schwartz & Gross, Archts., 347 5th Ave., will build a 14 story, 57 x 105 ft. apartment on Park Ave. and 38th St. About $750,000. Work will be done by day labor.

N. J., Princeton—The Bd. of Trustees of Princeton University, has awarded the contract for a 3 story, 35 x 170 ft. apartment addition on the Campus, including a steam heating system, to Matthews Constr. Co., Alexander St. About $325,000.

Pa., Philadelphia—The Trustees of Temple University, Broad and Berks Sts., have awarded the contract for a 6 story, 100 x 150 ft. building on Broad and Montgomery Sts., to Ketcham & McQuade, 1029 Brown St., $740,000. Noted Aug. 16.

Pa., Pittsburgh—The Bell Telephone Co., 416 7th Ave., has awarded the contract for a 20 story telephone office on 7th Ave., to W. F. Trimble & Sons, 1719 Pennsylvania Ave. About $1,900,000.

Md., Baltimore—The Cook Nuts Corp., W. R. Spruill, Pres., Paca and Lexington Sts., has awarded the contract for a 4 story, 50 x 104 ft. factory, including a power plant and machine shop, on 1st and Toon Sts., to C. L. Stockhausen, Gay and Water Sts., $85,000.

O., Akron—The Bd. Educ. has awarded the contract for a 2 story, 70 x 166 ft. and 70 x 120 ft. auditorium and gymnasium for the Caldwell School on Dayton St., to the Carmichael Constr. Co., Main St., $189,000. Noted Sept. 6.

O., Cleveland — The Bd. Educ., F. G. Hogen, Dir., East 6th St. and Rockwell Ave., has awarded the contract for a heating plant for the John Adams School, to the Industrial Heating & Eng. Co., 1063 Windsor St., Akron, $140,421.

O., Dayton—The Bd. Educ. has awarded the contract for a 3 story school on Home Ave., to the Drummond-Miller Co., 4500 Euclid Ave., Cleveland, $343,500.

O., Ravenna — The Bd. Educ., W. J. Dodge, Clk., has awarded the contract for a 2 story, 110 x 225 ft. high school to the Watts-Subriber Co., 1235 Miami St., Toledo, $359,809. Noted Aug. 30.

Mich., Detroit—The Street Ry. Comn., 155 West Congress St., has awarded the contract for furnishing and installing 3 horizontal cross-drum water tube boilers in the car shops heating plant, to Heine Safety Boiler Co., 5319 Marcus St., St. Louis, Mo., $15,430; for installing heating system, to Glantz & Killian, 424 East Atwater St., Detroit, $9,400. Noted Aug. 16.

Mich., Detroit—The Water Bd. East Jefferson Ave., has awarded the contract for furnishing and installing four 400 hp. water tube boilers for water works pumping station, to the Wickes Boiler Co., 512 North Water St., Saginaw, $36,187; stokers to the American Eng. Co., Aramingo and Cumberland Sts., Phila., Pa., $22,995. Noted Sept. 6.

Ill., Chicago — J. B. Murphy Memorial Hospital, c/o Giover & Dinkelberg, Archts., 400 North Michigan Ave., has awarded the contract for a 4 story, 158 x 190 ft. hospital on Belmont Ave. and Bway., to J. W. Snyder & Co., 122 South Michigan Ave. About $700,000. A steam heating system will be installed.

Ill., Chicago—The North Michigan Building Corp., 65 East Huron St., has awarded the contract for installing, heating and plumbing systems in the proposed 7 story, 44 x 102 ft. office and studio building at 27-29 East Superior St., to T. J. Douglas & Co., 44 North Dearborn St.

Neb., Chadron—The Bd. Educ., c/o F. B. Uthank, Secy., has awarded the contract for a 2 story, 80 x 160 ft. high school to I. E. Mulhollen. About $300,000. A steam heating system will be installed.

Mo., St. Louis—The Scottish Rite Cathedral Assn., La Salle Bldg., has awarded the contract for a 4 story, 125 x 230 ft. temple on Lindell and Grand Sts., to John Hill Constr. Co., Syndicate Trust Bldg. Cost plus percentage basis. About $1,000,000. Noted March 24.

Cal., Los Angeles—W. W. Paden and Associates, 427 Story Bldg., have awarded the contract for a 10 story, 54 x 130 ft. loft building on 7th and Bexel Sts., to H. Leonhardt, H. W. Hellman Bldg., $289,000. A steam heating system will be installed. Noted May 10.